PATIENT ACTIVATION AMONG HIGH-RISK PATIENTS: DOES THE PATIENT ACTIVATION MEASURE PREDICT UTILIZATION?

by

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Abstract

Integrated delivery systems increasingly seek to identify high-risk patient sub-groups where effective interventions can reduce costs. Most predictive models for utilization incorporate un-modifiable factors such as health status, clinical severity, and demographics. In contrast, patient activation – the beliefs, knowledge, and skills that support self-management behavior – is modifiable. We explore whether activation, measured by the Patient Activation Measure (PAM), predicts utilization and whether motivational interviewing (MI) improves patient activation.

We analyzed a retrospective cohort of high-utilizing Medicaid patients enrolled in a MI program who completed PAM surveys between 2009 and 2011. We used proportional hazard models to predict time to emergency department (ED) visits and hospitalizations using PAM, clinical risk, and health status as main predictors. We used generalized estimating equations to model PAM score change based on type of MI intervention. We explored interactions of demographics and patient engagement with key predictors. Our eligible population included 1,676 patients from four medical centers within Kaiser Permanente Northern California (KPNC), a large integrated health care delivery organization. Our study population comprised 1,041 patients (62 percent) who completed ≥1 PAM surveys.

While the relationship between activation with ED visits was insignificant in fully adjusted models, lower activation was associated with higher ED visit risk (HR: 1.40, $p<0.01$) for patients lacking stable primary care physician relationships. The association of activation with hospitalization was insignificant after adjusting for clinical risk. For the 915 patients with 2+ PAM surveys, the overall MI intervention was associated with an unadjusted first PAM-to-last PAM mean score improvement of a clinically meaningful 4.1-points ($p<0.01$). Lower activation patients received the most interventions (PAM Level 1: 2.5/month; Level 2: 1.9/month; Level 3: 1.7/month; Level 4: 1.5/month; χ^2 $p<0.01$) and improved the most (adjusted PAM score change

for Level 1 versus Level 4: 12.7 points; Level 2 versus Level 4: 11.9; Level 3 versus Level 4: 8.6; all $p<0.01$).

We infer that PAM may be more useful for targeting interventions for behavior sensitive outcomes such as ED visits. MI seems to be effective in improving activation in this complex patient population.

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Chapter 1: Introduction

The Problem

This project is motivated by a three-part problem facing integrated Health Maintenance Organizations (HMOs), Accountable Care Organizations (ACOs), and other provider organizations responsible for the total cost of care for individuals:

1. Health care costs are concentrated among people with multiple chronic conditions. The concentration of expenditures has long been a fundamental characteristic of health care markets. Based on the Medical Expenditure Panel Survey (MEPS), 1% of the population accounted for 22% of 2010 health care costs, and 5% of the United States population accounted for 50% of costs.[1] About one-third of this 5% were in the top 5% group in both 2009 and 2010.[1] An analysis of Medicare's 2010 acute-care expenditures found that 10% of patients account for 70% of the total costs.[2] "Failures of care coordination" where patients "fall through the slats in fragmented care" account for between $25 and 45 billion in 2011 of waste, and between 1.0% and 1.7% of total health care costs.[3] Failure of care coordination is an especially important problem for people with chronic conditions, particularly multiple or complex chronic conditions. Two-thirds of total healthcare spending is for people with multiple chronic conditions, and 79% of Medicare spending is for people with five or more chronic conditions.[4]
2. We don't have a solution, certainly not a cost-effective one. The chronic care and medical home models provide clear roadmaps for action for patients with high medical needs. These models envision continuous support by a multi-disciplinary care team following evidence-based guidelines with strong decision support, providing support for patient self-management, and coordinating with community resources to provide social support.[5-7] Care providers have designed innovative solutions based on these models that

make for excellent case studies and best practice summaries,[8,9] but they have not yet fine-tuned these practices in a way that reduces total healthcare costs, or covers the administrative costs of the programs. A comprehensive evaluation of Medicare's six major disease management and care coordination demonstration programs found little or no effect on hospital admissions or net Medicare expenditures.[10]

3. Accountable providers and insurance companies are under significant pressure to solve this problem cost-effectively. Although many of these forces were always in place, changes from the Affordable Care Act (ACA) and major purchaser policies have intensified the importance of a solution. Medicare has reduced payments to Advantage plans eliminating their long-time overpayment, the state and federal insurance exchanges create an intensely price competitive market for individual insurance, and major purchasers are moving toward risk adjustment which makes risk avoidance strategies increasingly difficult.

In developing cost-effective care management strategies for high-cost patients, healthcare providers might face important cultural obstacles: are the shared beliefs of healthcare professionals about high-cost patients helping them to identify the best solutions or are they getting in the way?

Stereotypes about high-cost patients

Although the word *stereotype* is commonly defined as having an over simplified or inaccurate view of a person or group, social psychologists define the term without this negative connotation as "the typical picture that comes to mind when thinking about a particular social group" or, more simply, "shared beliefs about the group."[11] Three principles guide social psychologist's thinking about stereotypes:[12]

1. Stereotypes are aids to explanation. "We cannot have an impression of a group unless we can tell the difference between that group and some other group. Categorization is the cognitive process by which we detect those differences and similarities."
2. Stereotypes are energy-saving devices. "Treating people as group members saves energy because it means that we can ignore all the diverse and detailed information that is associated with individuals."
3. Stereotypes are shared group beliefs. "They are shared by members of the group not just through the coincidence of common experience or the existence of shared knowledge within society, but because the members of groups act to coordinate their behavior."

Stereotypes are "a functional means for simplifying a complex environment."[11] As a manager of a care coordination team, these three characteristics would be helpful for reliably delivering care if our stereotypes about high-cost populations were correct. However, our lack of success in delivering cost-effective interventions suggests that we need to challenge our stereotypes.

The words we use represent the attitudes, or prejudices, we have towards a group.[11] In healthcare, we use a variety of words to categorize problematic patients that probably represent our attitudes and beliefs: non-compliers, non-adherers, non-responders, no-shows, or FTKAs (patients who fail to keep appointments). Understandably, as a caring profession trained to heal illness, the words articulate the behavioral gap between what patients do and what healthcare professionals know they need to do. Although these attitudes occasionally lead to discriminatory action, like discharging or withholding services from "noncompliant" patients, usually healthcare providers, particularly those in integrated systems responsible for the full cost of care, seek to identify patients with clinical barriers, and find creative ways to overcome them. Innovative providers are also seeking to identify and address non-medical barriers such as literacy, access to food, transportation, adequate housing, and supportive environments.[8] However, viewing high-

cost patients through the lens of their failures, deficits, and barriers might not be the best way to engage patients in taking care of their own health.

Moving from "what's the matter" to "what matters to you"

Whether focused on medical or non-medical needs and barriers, healthcare providers are taking the approach of diagnosing and treating diseases and problems. At the Institute for Healthcare Improvement's 2013 National Forum, Maureen Bisognano challenged attendees to flip healthcare, as some educators have flipped the purpose of the classroom, by changing our framing from "what's the matter" with the patient to "what matters" to the person we are serving.[13] Although few might argue with this recommendation in concept, it challenges the shared beliefs (stereotypes) among healthcare professionals about what patients really need.

We know that self-care behaviors are crucial for living well with chronic disease, but the best strategies for achieving improvements in self-management are unclear. For example, studies of patients with heart failure show equivocal or negative evidence of better outcomes for patient self-management support interventions compared to standard education.[14,15]

Cost effectively engaging patients in self-management requires investigation of the best ways to match the care delivery systems actions to what matters to patients; and, to identify whether patients need our help in achieving their goals, or whether they have the self-management motivation and skills to reach their goals with little assistance.

Motivational Interviewing and the Patient Activation Measure

Motivational interviewing (MI) is a promising approach for improving self-care behaviors and "acknowledges the patient's expertise into his or her own problems and empowers the patient to develop his or her own motivation."[16] MI is a collaborative process for resolving a person's ambivalence about change and choosing actions that motivate a person, as opposed to a typical

clinical encounter where a patient's problems are diagnosed, and they are prescribed actions and treatments. Recent meta-analyses found that motivational interviewing (including brief intervention) improved self-efficacy, engagement, health behaviors, medication adherence, clinical markers, and quality of life.[16-18] However, MI's cost-effectiveness is less clear.[19,20]

Patient activation as measured by the Patient Activation Measure (PAM) may be a practical way to customize an MI intervention to the patients who would benefit the most.[21,22] The original study developing the PAM measure defined activated patients as those who:

> ...*believe* [they] have important roles to play in self-managing care, collaborating with providers, and maintaining their health. They *know* how to manage their condition and maintain functioning and prevent health declines; and they have the *skills and behavioral repertoire* to manage their condition, collaborate with their health providers, maintain their health functioning, and access appropriate and high-quality care.[23]

Tailored MI interventions based on the level of patient activation may have the potential for cost-effectively improving behaviors and outcomes. Patients at lower levels of activation may receive higher intensity interventions aimed at building a belief that what they do matters for their health, and patients at higher levels of activation may receive lower intensity, and less expensive interventions, aimed at assisting them in staying on track during times of stress.

Research Question and Study Objectives

This project aims to help healthcare providers identify categories of high-cost patients who would benefit the most from self-management support interventions. Our broader question is whether the PAM can assist healthcare providers to target MI interventions to improve patient-centered outcomes and decrease costs. Because we were not able to design and implement a randomized experiment of this approach, we focused our research on an existing cohort of high-cost Medicaid patients who completed PAM surveys and received MI interventions. For this group, we asked the question:

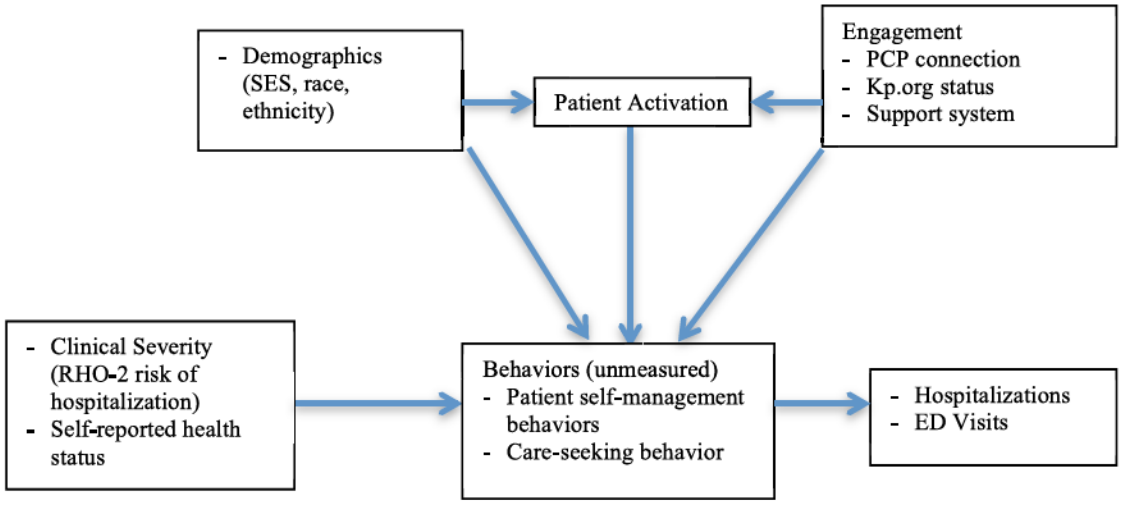
Does the level of a patient's activation independently predict future utilization, and, if so, do motivational interviewing interventions improve patient activation?

We pursued the following research objectives:

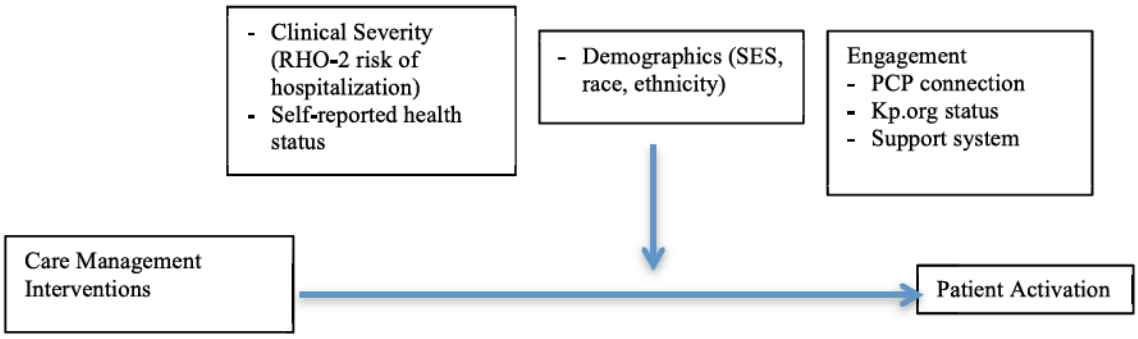
1. Develop a predictive model for risk of future hospitalizations for groups of high-utilizing patients using clinical risk, prior utilization, self-reported health status, and patient activation as the key predictor variables (see Model A in Figure 1). This predictive model examined the extent to which patient activation modifies the relationships between clinical risk, health status, and future utilization. Development of this model included the exploration of the interaction of patient activation with demographic and engagement factors that could confound or modify the effect of patient activation on utilization.
2. Develop a predictive model for future emergency department (ED) visits (see Model A in Figure 1). We anticipated that this model would include different factors than the hospitalization predictive model because the causes of ED visits may be different. Developing this model also included the exploration of confounding and modification of effects by demographic and engagement variables.
3. Develop a longitudinal model to predict changes in patient activation based on the frequency and types of interventions by care managers trained in motivational interviewing (see Model B in Figure 1).

Figure 1: Conceptual Models

Model A: Conceptual Model for How Factors Interact, with Utilization as Outcome



Model B: Patient Activation as Outcome



List of Acronyms

ACO: Accountable Care Organizations

ACS: US Census Bureau's American Community Survey

AHRQ: Agency for Healthcare Research and Quality

BMI: Body Mass Index

CMS: Center for Medicare and Medicaid Services

DxCG: Diagnosis Cost Group

ED: Emergency Department

EMR: Electronic Medical Record

GEE: Generalized Estimating Equations

HR: Hazard Ratio

KPHC: Kaiser Permanente Health Connect, Kaiser Permanente's EMR system

KP.org: the online portal for Kaiser Permanente members to view their medical record and interact with providers

KPNC: Kaiser Permanente Northern California

MEPS: Medical Expenditure Panel Survey

Medi-Cal: California's Medicaid program

MI: Motivational interviewing

PAM: Patient Activation Measure

PCP: primary care physician

PQI: AHRQ's Prevention Quality Indicators

RHO-2: hospitalization risk statistic developed by Kaiser Permanente's Division of Research

SES: Socioeconomic Status

Manuscript I: Predicting hospitalizations using the Patient Activation Measure

Importance: Integrated delivery systems increasingly seek to intervene effectively with patients at high hospitalization risk. Most predictive models use unmodifiable factors such as health status, clinical severity, and demographics. Measurement of patient activation – the beliefs, skills, and knowledge for self-management – could identify high-risk patients who would benefit most from interventions.

Objective: To estimate the predictive value of the Patient Activation Measure (PAM) on future hospitalization among high-risk Medicaid patients.

Design: Retrospective cohort study from December 2009 through December 2011.

Setting: Four medical centers within Kaiser Permanente Northern California (KPNC), a large integrated healthcare delivery organization.

Participants: Our eligible population included high-risk Medicaid patients aged 18-62 who had at least 10 months of KPNC membership, lived at home, and were enrolled in a care management program. High risk was defined as 2-8 emergency department (ED) visits or hospitalizations in the prior year or Diagnosis Cost Group (DxCG) score of >= 3. From this eligible population, 1,041 of 1,676 (62%) patients completed a PAM survey and are the subject of this analysis.

Main Outcome Measure: Number and time to first hospitalization.

Results: Participants were typical of non-elderly, high-cost California Medicaid patients: mean age, 38 years; 20% Hispanic; 45% African-American; DxCG mean score, 4.6; 55% obese or morbidly obese; 38% disabled. There were 532 hospitalizations and 1548 person-years at risk during follow-up for an event rate of 0.34 hospitalizations per person-year. In fully adjusted models, hospitalization risk was explained best by health status, clinical factors, prior utilization

and engagement factors. Although not statistically significant, lower activation was associated with higher hospitalization risk among members with significant support systems (PAM Level 1, 2, or 3 versus PAM Level 4 HR=1.57, p=0.07), and was associated with lower hospitalization risk among patients with some or no support system (PAM Level 1, 2, or 3 versus PAM Level 4 HR=0.78, p=0.11).

Conclusions and Relevance: In a high-risk Medicaid population, PAM had a weak and inconsistent relationship with higher hospitalization risk. These findings suggest that patient activation might not be strongly associated with hospitalization, an event that may be less sensitive in the short term to patient behavior.

Introduction

The concentration of expenditures is a fundamental characteristic of healthcare markets. Based on the Medical Expenditure Panel Survey (MEPS), 1% of the United States population accounted for 22% of healthcare costs in 2010, and 5% accounted for 50% of costs.[1] About one-third of this 5% population were also in the top 5% group in 2009.[1] Healthcare managers make substantial effort to find ways to reduce costs in these highest risk patient populations.

A substantial portion of healthcare expenditures may be preventable.[3] A 2011 National Healthcare Quality Report estimated that the nation spent $26 billion in 2008 on potentially avoidable hospitalizations.[24] Other research has found that up to one-fifth of hospitalizations for diabetic seniors are preventable.[25] Prior studies have found that clinical risk,[26-30] self-reported health status,[31,32] and demographic factors (race, socioeconomic status, insurance status)[1,25,33-35] are correlated with high or preventable utilization. Identifying these unmodifiable risk factors, however, does not help to inform the design of interventions to reduce healthcare utilization. Indeed, a comprehensive evaluation of Medicare's six major disease management and care

coordination demonstration programs found little or no effect on hospital admissions or net Medicare expenditures.[10]

Measuring patient activation is a potentially innovative approach for guiding interventions to reduce future utilization.[22] Patient activation is defined as a patient's beliefs, knowledge, and skills for engaging in self-management behavior, and has been standardized through the 13-item Patient Activation Measure (PAM) (Appendix Table 14).[36] While there is modest evidence that the PAM predicts future utilization controlling for clinical risk, health status, and demographic factors,[37-40] this relationship has not been studied within the high-risk, non-elderly Medicaid population that represents one of the major sources of our nation's health expenditures. We tested the hypothesis that PAM scores predict hospitalization in this high-risk population after controlling for clinical severity, self-reported health status, and patient engagement with healthcare providers.

Methods

Study design

We conducted a retrospective cohort analysis of high-risk Medicaid patients enrolled in a care management program implemented within an integrated health system. The program included assessment of patient activation using PAM surveys. Members were eligible if they were current Kaiser Permanente Northern California (KPNC) Medicaid members and:

1. Had at least 10 months of Medicaid membership, and were not a Medicare member;
2. Were ages 18 through 62;
3. Had two to eight ED visits or hospitalizations (excluding maternity) in the past twelve months or Diagnosis Cost Group (DxCG)[41] prospective score of greater than 3 (4 for the first two enrollment groups); and,
4. Were not a resident of a skilled nursing facility or hospice.

Setting and Participants

KPNC is a nonprofit, integrated healthcare delivery system providing comprehensive medical care to a diverse population of approximately 3.4 million members. Distribution of patient demographic and socioeconomic factors is similar to that of the area population, except at the extremes of the income distribution.[42] All healthcare utilization is recorded within a comprehensive electronic medical record (EMR).

Our study period begins at the point of completion of the first PAM survey, as early as December 2009, and ends at the time of the patient's death or December 31, 2011, the end of the care management program. We did not track utilization beyond December 2011 because the intensity of interventions was a key covariate that ended at that time.

Our study period is the second phase of the care management program that began 22 months earlier. Care managers at four geographically defined service areas received lists of eligible Medicaid members in February 2008, August 2008, December 2008, June 2009, and December 2009. Care managers enrolled members in the program and completed a baseline patient assessment. Each service area had a dedicated team comprising one registered nurse, two licensed vocational nurses, and one licensed clinical social worker. Beginning in December 2009, all care managers were trained in motivational interviewing and PAM administration. We considered members to be "PAM eligible" if they met the following criteria:

1. Coded as "enrolled" as of or at any time after December 1, 2009; or,
2. Had >=1 intervention or attempted contact after December 1, 2009.

Care managers were instructed to attempt a PAM survey and conduct interventions at least every three months; however, this practice varied. As part of a quality improvement project, care managers administered the PAM by phone, occasionally in person, and by mail before any care

management intervention. Many care managers followed up with members after a hospitalization or ED visit. Members received a $10 gift card for completing their first PAM survey.

Sources of Analytic Variables

We obtained age, gender, date of death, membership status, and home zip code from KPNC membership files; and obtained race/ethnicity, spoken language, smoking status, disability, and body mass index (BMI) from the EMR. Chronic conditions (e.g. hypertension, diabetes, asthma, heart failure, and depression) were identified using KPNC's population care registry archives, which are updated quarterly. For socioeconomic status (SES), we obtained zip code-level poverty rate, median household income, high school graduation rate, and college graduation rate from the United States Census Bureau's 2007-2011 American Community Survey (ACS). We created a binary pregnancy variable if a member had any maternity hospital encounters from September 2009 through June 2012.

When attempting to enroll members, care managers asked about working status, informal (non-health care provider) support system ("none", "some", or "significant"), and substance use; or, care managers assessed these three variables from a chart review. Care managers also administered a six-item intake questionnaire (Appendix Table 16) on experience of care and health status (with wording very similar to the first question on the SF-36 survey, with identical response categories).[43]

We created variables for the number of unique case management intervention days six months and twelve months before each analysis interval (see Appendix Table 20 for summary of interventions by type). Because members might have different hospitalization rates based on the intensity of the pre-PAM intervention, we created variables for the number of intervention days and for the elapsed time from first program intervention to the first PAM survey.

Clinical risk and utilization

For clinical risk of hospitalization, we used a validated predictive model that incorporates age, gender, diagnostic information and the key lab results.[27] This measure has higher predictive value than DxCG by making use of lab result information not easily available in systems without an integrated EMR.

We used hospital days and ED visits in the previous year as covariates to control for baseline differences among members. We created variables for the total number of hospital days for each member during the six months and one year before the start of each analysis interval. We created variables for the total number of ED visits six months and twelve months before each member's inclusion on one of the five enrollment lists, and six and twelve months before each member's first PAM survey. Hospitalizations, excluding maternity and psychiatry, and ED visits include care at KPNC and outside facilities and were collected from the EMR and outside billing records.

Engagement proxies

To explore whether the predictive value of the PAM could be achieved through simpler methods, we created variables that could be substitutes for patient activation. We included the intake question "Does your physician understand your healthcare needs?" because prior research has shown that the PAM score was strongly associated with the Roter Doctor-patient Communication Scale.[44] We included the support system assessment because of the possible overlap with the PAM construct. We also included whether a member was enrolled in another care management program, had a primary care physician (PCP), had a visit with this PCP during the previous two years, and whether a member had the same PCP during the previous twelve months, because prior research has demonstrated the link between PCP relationship and higher quality of care.[45] The EMR includes a web-based member portal, KP.org, which allows members to view components

of medical records online and to securely email with their physician. We created variables for the total number of logins to KP.org, and total number of sent and read messages.

PAM Score and Level

Raw scores for the PAM are calculated by assigning the values of 1-4 to responses from Disagree Strongly to Agree Strongly: patients are less likely to agree with each successive item in the survey (Appendix Table 14). A Rasch scoring table converts curvilinear summated raw scores to linear, interval scores in the range of 0 (lowest activation) to 100 (highest activation). Patients are classified into four activation levels (1=lowest activation, 4= highest activation) based on their score (Appendix Figure 5). The four-level structure was based on theory and psychometric properties from the PAM's original development.[23] This structure was confirmed in subsequent psychometric research as different versions of a three-level structure.[46,47]

Outcome measure: Hospitalization

Our primary outcome was the number of inpatient hospitalizations and time to the first inpatient hospitalization during the follow-up period.

Statistical analysis

We analyzed the distribution of study participation rates and first PAM survey level by patient characteristics, testing for differences using χ^2 tests and Kruskal-Wallis tests. We calculated the annualized hospitalization rate per time at-risk by patient characteristics. We categorized the annualized hospitalization rate into three groups: 0, >0-1, and >1 hospitalization per year. Time at-risk is the duration from the first PAM survey to the study end date (or patient death). Patients were not at-risk during a hospitalization. To test for differences in covariates by hospitalization rate category, we used χ^2 tests for categorical variables and Kruskal-Wallis tests for continuous variables.

We used Cox proportional hazards models to examine unadjusted and adjusted relationships between time to first hospitalization during the follow-up period and PAM, demographics, health status, health condition, clinical risk, prior utilization, study characteristics, and engagement variables. Because participants could have completed multiple PAM surveys, and because key covariates changed over the course of the study, we used the counting process style of input to represent time-dependent repeating covariates. We created a new record in the analysis dataset for each follow-up PAM survey a member completed and created new values for the following covariates that could have changed: intervention days, clinical risk score, hospital days, PCP status, PCP visit, smoking, BMI, other care management, and chronic conditions. Each time-dependent covariate was represented with its value in the month of the PAM survey, or its most recent value before that month. A patient's observation was censored on the date of death. Because we did not have reliable information on disenrollment, no participants were censored for loss to follow-up. In exploratory data analysis, we found that very few members had gaps in membership during the follow-up period, and the utilization rate during gaps in enrollment was similar to the utilization rate during enrollment.

We included all variables with p-values lower than 0.25 in the univariate analyses in the initial multivariable Cox analyses. We did not include age and gender because they are already included in the clinical risk score. We kept variables in the multivariable models with p-values <0.10, if they caused significant confounding or they improved model fit. PAM and race/ethnicity were retained in each model. We categorized continuous variables or combined categories based on linear Wald hypothesis tests. We explored PAM as a continuous variable and by the four PAM Levels. We explored interactions between the three key predictor variables – PAM, clinical risk/utilization, self-reported health status – and all other significant covariates on the outcome. We confirmed the proportionality assumption of the Cox model, and substituted variables in models displaying excessive multicollinearity.

For the subgroup analyses, we explored the effect of change in PAM score (in continuous and quartile form) for participants with multiple PAM surveys, and explored the effect of pregnancy for female participants. For sensitivity analyses, we explored multiple final models. We also constructed and tested a time to recurrent event model that used all hospitalizations in the follow-up period. For all analyses, we did not include the approximately 1% of patients with missing values for self-reported health status or support system.

Analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, North Carolina). The Kaiser Permanente and Johns Hopkins Bloomberg School of Public Health IRBs approved this study.

Results

Study Participants

Of the 2,973 members selected for the care management program, 1,254 did not enroll, were excluded by care managers, or could not be reached (Figure 2). An additional 40 members were initially enrolled, but were dis-enrolled before December 2009 and received no additional interventions or attempted contacts. Of the remaining 1,679 members, 1,041 completed at least one PAM survey and are the subject of our analysis ("PAM cohort"). For these patients, the median (interquartile range) follow-up time was 570 days (458-642), and all but four follow-up times were greater than six months. The overall study participation rate (PAM completion/PAM eligible) was 62%.

PAM eligibles were different from the PAM ineligibles (Table 1, all $p \leq 0.01$) by being more female (82% versus 76%); much less Hispanic (24% versus 44% Hispanic) and 42% versus 25% African-Americans, with slightly lower SES (16.7% versus 16.1% poverty rate, and 24.0% versus 24.9% college graduation rate); and more obese (56% versus 47% obese/morbidly obese). PAM eligibles had higher rates of asthma (29% versus 21%), hypertension (32% versus 23%),

diabetes/cardiovascular disease (25% versus 18%), slightly lower clinical risk (4.9 versus 5.0 DxCG score), and higher ED visit rates (2.0/year versus 1.7/year). PAM eligibles had closer engagement with PCPs (89% versus 73% with recent PCP visits, and 83% versus 75% with stable PCP relationships).

PAM cohort participants had a mean age of 38 years, were 84% female, and were 20% Hispanic, 45% African-American and 26% white. The PAM cohort was different from program-enrolled members without PAM surveys (Table 1, all $p \leq 0.05$) by being more female (84% versus 78%), much less Hispanic and more African-American, lower SES (17.1% versus 16.2% poverty rate; 23.5% versus 24.8% college graduation rate). Clinically, the PAM cohort was less disabled (38% versus 45%), more likely to be pregnant (17% versus 10%), and had lower DxCG scores (4.6 versus 5.3), and fewer hospital days (1.2 versus 1.7). PAM participation rates were lower for the first three cohorts enrolled in the case management program (55%, 57%, and 56%) and much higher for the last cohort (93%). The PAM cohort was less likely to have a significant support system (25% versus 39%). Thirty-seven percent of PAM cohort participants were in the two lowest PAM Levels (Table 2). Lower activation patients were older ($p<0.01$), and had lower health status ($p<0.01$), higher disability rates ($p<0.01$), higher depression rates ($p<0.01$), higher hypertension rates ($p=0.04$), higher ED visit rates ($p<0.01$), and lower reported rates of their physicians understanding their healthcare needs ($p=0.01$). A total of 88% of subjects completed at least two PAM surveys, 63% completed at least four, and the median (interquartile range) of time to second PAM survey was 98 days (90-154) (Appendix Table 15).

Hospitalizations

The study group had a total of 532 hospitalizations during the follow-up period and 1,548 person-years at-risk corresponding to an annual event rate of 0.34 hospitalizations. Nearly three-quarters had no hospitalizations and 16% had only one. Patients with higher hospitalization rates during the study period were older age, were more white and less Hispanic, had much lower health

status, had much higher rates of disability, obesity and chronic disease (except for asthma), much higher hospitalization risk, much higher previous utilization, more likely to have had ≤9 intervention days, and were more likely to have read multiple secure messages (Table 3, $p \leq 0.02$ for all).

In univariate analysis, PAM did not have a significant relationship with hospitalization risk (Table 4). In multivariable analysis, the largest magnitude predictors were predicted hospitalization risk (fifth versus first quintile HR: 3.51, $p<0.01$), heart failure (HR: 1.98, $p<0.01$), and ≥3 hospital days in the previous 12 months (HR: 1.64, $p=0.02$). High self-reported health status was associated with lower hospitalization risk (HR: 0.60, $p=0.01$).

PAM was associated with hospitalization risk only in interaction with level of support system, although these relationships were not significant at the 5% level. Lower activation was associated with higher hospitalization risk among members with significant support systems (PAM Level 1, 2, or 3 versus PAM Level 4 HR=1.57, $p=0.07$), and was associated with lower hospitalization risk among patients with some or no support system (PAM Level 1, 2, or 3 versus PAM Level 4 HR=0.78, $p=0.11$). Among patients at PAM Levels 1, 2, or 3, having some/no support, compared to significant support, was associated, counter-intuitively, with a lower hospitalization risk (HR: 0.59, $p<0.01$).

Models with alternative covariate inclusion produced similar coefficients for PAM, clinical risk, and health status. A recurrent event model of time to all hospitalizations found no significant relationships with PAM. In an analysis of patients with more than one PAM survey, we found that the change in PAM score from the most recent previous survey was not significantly related to hospitalization risk.

Discussion

We studied whether the PAM independently predicts hospitalization in a high-risk Medicaid population. Controlling for demographic and clinical covariates, PAM provided weak (not significant at 5% level) and inconsistent predictive value for hospitalization risk. The clinical implication is that patient activation may have limited utility in predicting hospitalizations in our high-risk Medicaid population, particularly when rich clinical information is available. This result supports the concept that hospitalization may be driven primarily by acute clinical events (e.g. infection, thrombosis) rather than patient behaviors (at least in the 1 to 2 year follow-up period of this study).

Among the 25% of patients with a significant support system, there was some evidence (p=0.07) that a PAM score below the highest activation level (Level 4) was associated with increased hospitalization risk. Having a significant informal support system might be a proxy for higher healthcare needs.

This study expands on previous literature by examining the correlation of PAM with subsequent hospitalization in a high-risk patient population with well-defined clinical risk covariates. Previous studies have found significant relationships between PAM and hospitalization but those studies focused on older populations with diabetes or heart failure,[37,39,40] or a general population served by a large health system.[38] Our different results could be explained by three factors. First, hospitalizations for our high-risk Medicaid patients might be less preventable. A recent study in a safety net hospital found a large and significant relationship between PAM and readmission, a more preventable outcome.[48] The small number of hospitalizations in our study prevented us from exploring a readmission analysis. Second, our patient population had much lower activation scores than a nationally representative sample: 37% were in the lowest two activation levels compared to 21% nationally, and only 30% were in the highest level compared to 41% nationally.[49] Variation in activation might matter less in an overall lower activation population,

although this is also inconsistent with other PAM literature. Third, there could be systematic differences between KPNC's integrated delivery system and the other environments where PAM has been studied.

A central question for operational and clinical leaders is whether PAM or other patient-centered assessments provide a useful guide to clinical intervention. Does PAM help identify which high-risk patients need intervention and which do not? From the Physician Group Practice Demonstration (PGPD)[50] to ACOs, federal policy aims to give integrated delivery systems the opportunity and incentive to improve patient well being at the lowest per capita cost. To improve the cost-effectiveness of care management interventions, patients at lower levels of activation might receive higher intensity interventions aimed at building a belief that what they do matters for their health, and patients at higher levels of activation might receive lower intensity, and less expensive interventions, aimed at assisting them in staying on track during times of stress. One large quasi-experimental study has provided some positive evidence that this tailoring approach works to improve outcomes and reduce utilization, but only for an employed population.[21] A randomized study of a diabetes peer-coaching intervention found that the intervention only had impact among patients with low or moderate baseline self-management skills; patients with high self-management skills improved equally with and without intervention.[51] This intervention-tailoring approach may be less effective in improving less preventable or behavior sensitive outcomes, such as this study's 1-2 year hospitalization risk.

The results of this study need to be interpreted within the limits of the study design. As an observational study, it is subject to unmeasured confounding and causality cannot be determined. In particular, to the extent that the care management intervention was effective, it could have dampened the association between PAM and hospitalization. However, with the exception of direct measurement of SES, rigorous measurement of social support, and health literacy, our data set was both rich and complete with a sophisticated clinical risk predictor, detailed measurement

of chronic conditions, complete historic utilization information, self-reported health status, and measures that could serve as proxies for patient engagement. We also used time-to-event statistical methods to maximize the information available from our data. However, our modest sample size limits our ability to detect smaller effects. Our study population is reasonably representative of the high-risk Medicaid group from which it was drawn, although bias is difficult to assess because of inconsistent effort to reach all potential participants. The apparently lower clinical risk in our study population compared to that of patients who did not complete at least one PAM survey is probably related to the underlying program design and not to biased selection. A disproportionately small, and possibly lower risk, group of Hispanic patients participated in the study, possibly because of language barriers.

After accounting for clinical risk, we did not find a strong association between PAM and hospitalization risk. The factors we found to be highly associated with hospitalization risk are not easily modifiable. Future randomized intervention studies are needed to test whether customizing interventions to patient activation levels can cost-effectively improve preventable utilization and behavior-sensitive outcomes.

Figure 2: Participant Selection

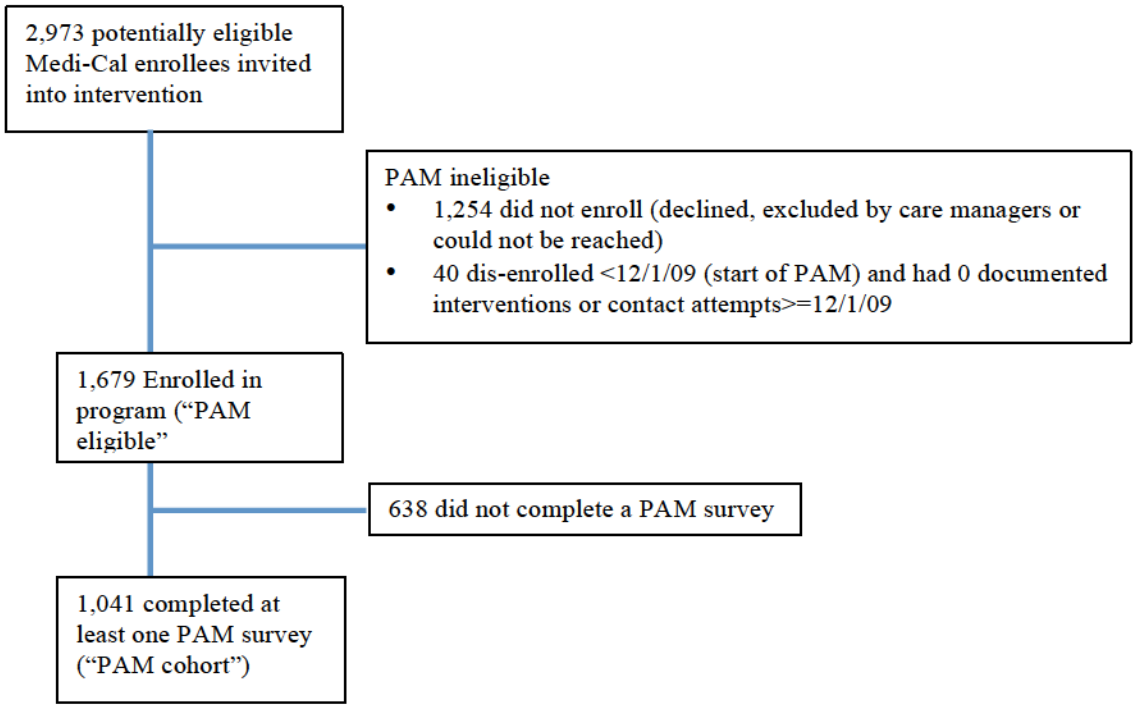


Table 1: Distribution of Member Characteristics by Participation Status

Member Characteristics (month of list creation unless otherwise specified)	**>= 1 PAMs** N=1041 (62%)		**0 PAM** N=638 (38%)		**p value**	**PAM eligible** N=1679 (56%)		**PAM ineligible** N=1294 (44%)		**p value**	**Potential Eligibles** N=2973 (100%)	
Socio-Demographic												
Age, mean	36.7		37.7		0.12	37.1		36.1		0.01	36.6	
Gender, male	164	16%	142	22%	0.00	306	18%	306	24%	0.00	612	21%
Missing			2	0%		2	0%				2	0%
Race												
Hispanic	210	20%	190	30%	0.00	400	24%	570	44%	0.00	970	33%
African American	470	45%	231	36%		701	42%	319	25%		1020	34%
Other	90	9%	60	9%		150	9%	141	11%		291	10%
White non-Hispanic	271	26%	156	24%		427	25%	264	20%		691	23%
Missing			1	0%		1	0%				1	0%
Preferred Verbal Language (as of 12/09)												
English	1005	97%	596	96%	0.39	1601	96%	1107	94%	0.02	2708	96%
Spanish and other	35	3%	26	4%		61	4%	65	6%		126	4%
Total non-missing	1040	100%	622	100%		1662	100%	1172	100%		2834	100%
Missing	1	0%	16	3%	0.00	17	1%	122	9%	0.00	139	5%
Home Medical Center												
East Bay	247	24%	153	24%	0.00	400	24%	334	26%	0.00	734	25%
Napa/Solano	262	25%	215	34%		477	28%	260	20%		737	25%
North Valley	288	28%	134	21%		422	25%	342	26%		764	26%
South Sacramento	244	23%	136	21%		380	23%	357	28%		737	25%
Missing								1	0%		1	0%
Poverty Rate (in home zip), mean	17.1%		16.2%		0.01	16.7%		16.1%		0.01	16.5%	
College Grad. Rate (in home zip), mean	23.5%		24.8%		0.02	24.0%		24.9%		0.01	24.4%	
Full or part-time work (at enrollment)	227	22%	109	20%	0.36	336	21%	28	29%	0.13	364	22%
Total non-missing	1034	100%	552	100%		1586	100%	98	100%		1684	100%
Missing	7	1%	86	13%	0.00	93	6%	1196	92%	0.00	1289	43%

Note: Column percentages for are calculated as a percent of total non-missing for that characteristic. Missing percentages are calculated as a percent of the column's total N. Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 1 (continued): Distribution of Member Characteristics by Participation Status

Member Characteristics (month of list creation unless otherwise specified)	**>= 1 PAMs** N=1041 (62%)		**0 PAM** N=638 (38%)		**p value**	**PAM eligible** N=1679 (56%)		**PAM ineligible** N=1294 (44%)		**p value**	**Potential Eligibles** N=2973 (100%)	
Health Status and Conditions												
Health Status (at enrollment)												
Poor	123	12%	95	17%		218	14%	29	13%		247	14%
Fair	308	30%	166	29%		474	30%	50	23%		524	29%
Good	400	39%	185	33%	0.03	585	37%	80	37%	0.18	665	37%
Very Good	135	13%	80	14%		215	13%	39	18%		254	14%
Excellent	64	6%	39	7%		103	6%	17	8%		120	7%
Total with response	1030	100%	565	100%		1595	100%	215	100%		1,810	100%
Missing survey/no response to question	11	1%	73	13%	0.00	84	5%	1079	83%	0.00	1163	39%
Smoking Status (at enrollment)												
Never Smoked	483	47%	281	46%		764	47%	541	49%		1305	48%
Not Current Smoker	255	25%	129	21%	0.07	384	24%	257	23%	0.67	641	23%
Current Smoker	282	28%	197	32%		479	29%	314	28%		793	29%
Total with Information	1020	100%	607	100%		1627	100%	1112	100%		2739	100%
Unknown (no information in EMR)	21	2%	31	5%	0.00	52	3%	182	14%	0.00	234	8%
BMI category (% of nonmissing)												
Normal/Underweight	197	19%	142	23%		339	21%	283	25%		622	22%
Overweight	242	23%	136	22%	0.09	378	23%	316	28%	0.00	694	25%
Obese	364	35%	225	37%		589	36%	364	32%		953	34%
Morbidly Obese	227	22%	111	18%		338	21%	172	15%		510	18%
Total with information	1030	100%	614	100%		1644	100%	1135	100%		2779	100%
Unknown (no information in EMR)	11	1%	24	4%	0.00	35	2%	159	12%	0.00	194	7%
Substance Abuse, self-report (at enrollment)	127	12%	101	18%	0.00	228	14%	17	17%	0.45	245	15%
Total non-missing	1034	100%	552	100%		1586	100%	98	100%		1684	100%
Missing	7	1%	86	13%	0.00	93	6%	1196	92%	0.00	1289	43%

Note: Column percentages for are calculated as a percent of total non-missing for that characteristic. Missing percentages are calculated as a percent of the column's total N. Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 1 (continued): Distribution of Member Characteristics by Participation Status

Member Characteristics (month of list creation unless otherwise specified)	**>= 1 PAMs** N=1041 (62%)		**0 PAM** N=638 (38%)		**p value**	**PAM eligible** N=1679 (56%)		**PAM ineligible** N=1294 (44%)		**p value**	**Potential Eligibles** N=2973 (100%)	
Health Status and Conditions (continued)												
Disabled	399	38%	284	45%	0.05	683	41%	475	37%	0.09	1158	39%
Missing								1	0%		1	0%
Pregnancy (% of females)	151	17%	51	10%	0.00	202	15%	120	12%	0.09	322	14%
Depression registry (as of 12/09)	397	38%	252	39%	0.66	649	39%	431	33%	0.02	1080	36%
Asthma registry (as of 12/09)	308	30%	172	27%	0.33	480	29%	274	21%	0.00	754	25%
Hypertention registry (as of 12/09)	325	31%	207	32%	0.67	532	32%	299	23%	0.00	831	28%
Heart Failure registry (as of 12/09)	36	3%	30	5%	0.21	66	4%	50	4%	0.93	116	4%
Diabetes/cardiovascular registry (as of 12/09)	254	24%	166	26%	0.52	420	25%	239	18%	0.00	659	22%
Clinical Risk												
DxCG Score (mean)	4.6		5.3		0.00	4.9		5.0		0.00	4.9	
ED Visits (12 mos prior to list), mean	2.0		2.1		0.26	2.0		1.7		0.00	1.9	
Hospital Days (12 mos prior to list), mean	1.2		1.7		0.00	1.4		1.6		0.78	1.5	
Study Characteristics												
List Release Date												
Feb-08	217	21%	181	28%		398	24%	304	23%		702	24%
Aug-08	228	22%	175	27%		403	24%	263	20%		666	22%
Dec-08	204	20%	161	25%	0.00	365	22%	272	21%	0.05	637	21%
Jun-09	173	17%	104	16%		277	16%	251	19%		528	18%
Dec-09	219	21%	17	3%		236	14%	204	16%		440	15%
Died before 12/1/09	0	0%	0	0%		0	0%	43	3%		43	1%

Note: Column percentages for are calculated as a percent of total non-missing for that characteristic. Missing percentages are calculated as a percent of the column's total N. Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 1 (continued): Distribution of Member Characteristics by Participation Status

Member Characteristics (month of list creation unless otherwise specified)	**>= 1 PAMs** N=1041 (62%)		**0 PAM** N=638 (38%)		**p value**	**PAM eligible** N=1679 (56%)		**PAM ineligible** N=1294 (44%)		**p value**	**Potential Eligibles** N=2973 (100%)	
Engagement in care/activation proxies												
Support system, self-report (at enrollment)												
Significant	256	25%	218	39%		474	30%	43	44%		517	31%
Some	716	69%	299	54%	0.00	1015	64%	54	55%	0.00	1069	63%
None	62	6%	35	6%		97	6%	1	1%		98	6%
Total non-missing	1034	100%	552	100%		1586	100%	98	100%		1684	100%
Missing	7	1%	86	13%	0.00	93	6%	1196	92%	0.00	1289	43%
>=1 PCP visit prior 2 yrs (as of 12/09)	926	89%	576	90%	0.78	1502	89%	946	73%	0.00	2448	82%
PCP status in last 12 months (as of 12/09)												
Same PCP, no change	871	84%	522	82%		1393	83%	965	75%		2358	79%
PCP added	36	3%	14	2%	0.00	50	3%	43	3%	0.00	93	3%
PCP changed	132	13%	86	13%		218	13%	160	12%		378	13%
No PCP as of 12/09	2	0%	16	3%		18	1%	126	10%		144	5%
Enrolled in care management (as of 12/09)	43	4%	36	6%	0.17	79	5%	39	3%	0.02	118	4%
>=1 login to kp.org prior 12 mos	224	22%	145	23%	0.61	369	22%	281	22%	0.88	650	22%
Sent secure messages prior 12 mos, mean	1.3		1.2		0.98	1.3		1.1		0.98	1.2	
MD understanding of needs (at enrollment)												
Poor	41	4%	26	5%		67	4%	9	4%		76	4%
Fair	99	10%	63	12%		162	11%	23	11%		185	11%
Good	281	28%	137	26%	0.30	418	27%	64	30%	0.69	482	28%
Very Good	264	27%	123	23%		387	25%	44	21%		431	25%
Excellent	310	31%	181	34%		491	32%	71	34%		562	32%
Total with response	995	100%	530	100%		1525	100%	211	100%		1736	100%
Missing survey/no response to question	46	4%	108	17%	0.00	154	9%	1083	84%	0.00	1237	42%

Note: Column percentages for are calculated as a percent of total non-missing for that characteristic. Missing percentages are calculated as a percent of the column's total N. Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 2: PAM Level by Member Characteristics

Member Characteristics (month of first PAM survey unless otherwise specified)	PAM Level from First Survey					
	1 N=179 (17%)	2 N=212 (20%)	3 N=303 (29%)	4 N=347 (33%)	P value	All N=1041 (100%)
Socio-Demographic						
Age, mean	40.2	39.7	38.0	36.5	0.00	38.2
Gender, male	32 18%	38 18%	43 14%	51 15%	0.60	164 16%
Race						
Hispanic	29 16%	45 21%	54 18%	82 24%	0.28	210 20%
African-American	79 44%	89 42%	141 47%	161 46%		470 45%
Other	14 8%	21 10%	30 10%	25 7%		90 9%
White non-Hispanic	57 32%	57 27%	78 26%	79 23%		271 26%
Language, Spanish	3 2%	9 4%	10 3%	14 4%	0.50	36 3%
Home Medical Center						
East Bay	24 13%	43 20%	70 23%	110 32%	0.00	247 24%
Napa/Solano	36 20%	56 26%	82 27%	88 25%		262 25%
North Valley	80 45%	62 29%	72 24%	74 21%		288 28%
South Sacramento	39 22%	51 24%	79 26%	75 22%		244 23%
Health Status and Conditions						
Health Status: Very good/excellent (11 missing) (at enrollment)	16 9%	26 12%	59 19%	98 28%	0.00	199 19%
Current smoker	57 32%	63 30%	86 28%	83 24%	0.35	289 28%
Morbidly obese	46 26%	56 26%	62 20%	70 20%	0.30	234 22%
Disabled (at enrollment)	95 53%	96 45%	106 35%	102 29%	0.00	399 38%
Pregnancy (% of females)	19 13%	32 18%	42 16%	58 20%	0.41	151 17%
Depression registry	99 55%	93 44%	102 34%	105 30%	0.00	399 38%
Hypertention registry	76 42%	77 36%	88 29%	101 29%	0.03	342 33%
Heart Failure registry	6 3%	13 6%	10	8 2%	0.13	37 4%
Diabetes/Cardiovascular registry	55 31%	65 31%	70 23%	64 18%	0.01	254 24%

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 2 (continued): PAM Level by Member Characteristics

Member Characteristics (month of first PAM survey unless otherwise specified)	PAM Level from First Survey								P value	All	
	1 N=179 (17%)		2 N=212 (20%)		3 N=303 (29%)		4 N=347 (33%)			N=1041 (100%)	
Clinical Risk and utilization											
Hospitalization risk, mean	7.8%		7.8%		6.0%		5.1%		0.00	6.4%	
>=3 ED Visits (12 mo before first PAM)	60	34%	68	32%	78	26%	69	20%	0.00	275	26%
>=3 Hospital days (12 mo before first PAM)	14	8%	20	9%	26	9%	21	6%	0.51	81	8%
Study Characteristics											
>=9 Interventions (six mo before first Pam)	17	9%	13	6%	20	7%	25	7%	0.04	75	7%
List date											
Feb-08	49	27%	53	25%	58	19%	57	16%		217	21%
Aug-08	40	22%	43	20%	64	21%	81	23%		228	22%
Dec-08	27	15%	38	18%	69	23%	70	20%	0.20	204	20%
Jun-09	32	18%	33	16%	49	16%	59	17%		173	17%
Dec-09	31	17%	45	21%	63	21%	80	23%		219	21%
Significant Support System, (7 missing) (at enrollment)	27	15%	45	21%	86	28%	98	28%	0.01	256	25%
Enrolled in care management	10	6%	18	8%	23	8%	20	6%	0.55	71	7%
PCP visit in the last two years	172	96%	195	92%	275	91%	311	90%	0.90	953	92%
PCP changed or added in last 12 months	21	12%	31	15%	39	13%	61	18%	0.29	152	15%
PCP added	1	1%	1	0%	2	1%	7	2%	0.20	11	1%
PCP changed in last 12 months	20	11%	30	14%	37	12%	54	16%	0.52	141	14%
PCP no change in last 12 months	21	12%	31	15%	38	13%	55	16%	0.57	145	14%
>=2 Read secure messages in past 12 months	33	18%	39	18%	51	17%	69	20%	0.85	192	18%
MD understanding: v good/excellent (46 missing) (at enrollment)	84	47%	111	52%	149	49%	230	66%	0.01	574	55%

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 3: Annualized Hospitalization Rate by Member Characteristics

Member Characteristics (month of first PAM survey unless otherwise specified)	Hospitalization rate (hospitalizations/year of at-risk time)				
	0 N=768 (74%)	>0-1 N=148 (14%)	>1 N=125 (12%)	P value	All N=1041 (100%)
Socio-Demographic					
Age (mean)	36.5	39.9	46.8	0.00	38.2
Gender, male	121 16%	15 10%	28 22%	0.04	164 16%
Race					
Hispanic	171 22%	26 18%	13 10%	0.01	210 20%
African-American	349 45%	69 47%	52 42%		470 45%
Other	60 8%	13 9%	17 14%		90 9%
White non-Hispanic	188 24%	40 27%	43 34%		271 26%
Home Medical Center					
East Bay	185 24%	39 26%	23 18%	0.50	247 24%
Napa/Solano	185 24%	43 29%	34 27%		262 25%
North Valley	214 28%	38 26%	36 29%		288 28%
South Sacramento	184 24%	28 19%	32 26%		244 23%
Health Status and Conditions					
Health Status: Very good/excellent (at enrollment)	170 22%	22 15%	7 6%	0.00	199 19%
Current smoker	210 27%	35 24%	44 35%	0.18	289 28%
Morbidly obese	153 20%	46 31%	35 28%	0.01	234 22%
Disabled (at enrollment)	261 34%	65 44%	73 58%	0.00	399 38%
Depression registry	266 35%	66 45%	67 54%	0.00	399 38%
Asthma registry	227 30%	45 30%	49 39%	0.20	321 31%
Hypertention registry	206 27%	65 44%	71 57%	0.00	342 33%
Heart Failure registry	14 2%	7 5%	16 13%	0.00	37 4%
Diabetes/cardiovascular registry	156 20%	36 24%	62 50%	0.00	254 24%

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 3 (continued): Annualized Hospitalization Rate by Member Characteristics

Member Characteristics (month of first PAM survey unless otherwise specified)	Hospitalization rate (hospitalizations/year of at-risk time)									
	0 N=768 (74%)		>0-1 N=148 (14%)		>1 N=125 (12%)		P value	All N=1041 (100%)	
Clinical Risk and utilization									
Hospitalization risk, mean	4.9%		7.0%		14.6%		0.00	6.4%	
>=3 ED Visits, prior 12 months	166	22%	54	36%	55	44%	0.00	275	26%
>=3 Hospital days, prior 12 months	36	5%	10	7%	35	28%	0.00	81	8%
Study Characteristics									
>=9 Intervention days, prior 6 months	46	6%	13	9%	16	13%	0.02	75	7%
Engagement/activation proxies									
PAM Level									
1st	118	15%	35	24%	26	21%	0.15	179	17%
2nd	152	20%	33	22%	27	22%		212	20%
3rd	231	30%	38	26%	34	27%		303	29%
4th	267	35%	42	28%	38	30%		347	33%
Support System, Significant (at enrollment)	178	23%	40	27%	38	30%	0.26	256	25%
Enrolled in care management	46	6%	12	8%	13	10%	0.18	71	7%
Had PCP Visit in the last two years	695	90%	136	92%	122	98%	0.74	953	92%
PCP changed or added in last 12 mos.	116	15%	22	15%	14	11%	0.57	152	15%
>=2 Read secure messages, prior 12 months	124	16%	35	24%	33	26%	0.01	192	18%
MD understanding: v. good/excellent (at enrollment)	413	54%	86	58%	75	60%	0.60	574	55%

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 4: Unadjusted and Adjusted Cox Proportional Hazard Estimates: Time to First Hospitalization

	Unadjusted		Adjusted	
	HR	90% CI	HR	90% CI
Race (Reference = Hispanic)				
African-American	0.70	(0.51 - 0.94)	1.37	(1.00 - 1.87)
Other	1.98	(1.33 - 2.95)	1.77	(1.18 2.67)
White non-Hispanic	1.80	(1.31 - 2.48)	1.28	(0.91 - 1.78)
Self-reported health status (Reference=Poor/fair/good)				
Very good/excellent	0.45	(0.33 - 0.62)	0.60	(0.43 - 0.83)
Disabled (reference = no)				
Yes	1.81	(1.48 - 2.20)	1.33	(1.07 - 1.67)
Heart failure registry (reference=no)				
Yes	3.41	(2.38 - 4.89)	1.98	(1.36 - 2.89)
Hospitalization risk, quintile (Reference = 1st)				
2nd	1.98	(1.36 - 2.90)	1.82	(1.24 - 2.69)
3rd	2.42	(1.67 - 3.51)	1.81	(1.22 - 2.69)
4th	4.10 [1]	(2.88 - 5.85)	2.95 [1]	(2.01 - 4.33)
5th	6.94 [2]	(4.85 - 9.90)	3.51 [1]	(2.29 - 5.38)
Hospital days, 12 mo before (Reference = 0-2)				
>= 3	3.81	(2.79 - 5.19)	1.64	(1.16 - 2.33)
ED visits, 12 mo before (Reference = 0-2)				
>= 3	2.23	(1.82 - 2.73)	1.50	(1.19 - 1.88)
Interventions, 6 mo before (Reference = 0-8)				
>= 9	1.76	(1.37 - 2.27)	1.46	(1.12 - 1.88)
PAM Level (Reference Level 4)				
Level 1, 2, or 3	1.15	(0.94 - 1.42)	See interactions below	
Support system			**PAM Level**	
Some/none	0.77	(0.61 - 0.95)	1, 2, or 3 0.93	(0.64 - 1.36)
			4 1.19	(0.80 - 1.76)
Significant	1.00		1, 2, or 3 1.57 [3]	(1.04 - 2.37)
			4 1.00	
Care Management (reference = no)				
Yes	1.24	(0.87 - 1.77)	0.68	(0.47 - 0.98)
Msgs read, 12 mos before (reference = 0-1)				
>=2	1.62	(1.28 - 2.03)	1.52	(1.19 - 1.94)

Note: all comparisons use 90% two-sided Wald confidence intervals
[1] significantly higher than 2nd and 3rd quintiles
[2] significantly higher than 2nd, 3rd, and 4th quintiles
[3] significantly higher than Some/none at same PAM Level ($p<0.01$), and significantly higher than PAM Level 4 ($p=0.07$).

Manuscript II: Predicting emergency department visits using the Patient Activation Measure

Importance: Integrated delivery systems increasingly seek to reduce Emergency Department (ED) overuse. However, most models used to predict ED visits incorporate unmodifiable patient factors such as prior utilization, health status, clinical severity, and demographic data. Models that include potentially modifiable measures may be more useful for identifying subsets of high-risk patients for tailored interventions.

Objective: To estimate the predictive value of the Patient Activation Measure (PAM) on ED visits among high-risk Medicaid patients.

Design: Retrospective cohort study from December 2009 through December 2011.

Setting: Four medical centers within Kaiser Permanente Northern California (KPNC), a large integrated healthcare delivery organization.

Participants: We studied high-risk Medicaid patients aged 18-62 who had at least 10 months of KPNC membership, lived at home, and were enrolled in a care management program to reduce future utilization. High risk was defined as 2-8 ED visits or hospitalizations in the prior year or Diagnosis Cost Group (DxCG) score of >= 3. From this eligible population, 1,041 of 1,676 (62%) patients completed a PAM survey and are the subject of this analysis.

Main Outcome Measure: Number and time to emergency department visits.

Results: Participants were typical of non-elderly, high-cost California Medicaid patients: mean age, 38 years; 20% Hispanic; 45% African-American; DxCG mean score, 4.6; 55% obese or morbidly obese; 38% disabled. There were 3,241 ED visits during follow-up and 1,550 person-years at risk (event rate=2.1 ED visits/person-year). Controlling for covariates with a Cox proportional hazards model of time to recurrent events, Level 1 PAM scores were associated with

higher ED visit risk among patients with unstable PCP relationships (HR: 1.40, p<0.01), with the effect concentrated among African-American (HR: 1.45, p<0.01) and Hispanic patients (HR: 1.47, p=0.05). ED visit risk was also strongly associated with clinical factors and prior utilization.

Conclusions and Relevance: In a high-risk Medicaid population, lower PAM scores were associated with higher ED visit risk among specific patient subgroups. Randomized intervention studies are needed to test whether tailoring interventions to increase patient activation levels in these subgroups can reduce preventable ED use.

Introduction

The concentration of expenditures is a fundamental characteristic of healthcare markets. Based on the Medical Expenditure Panel Survey (MEPS), 1% of the United States population accounted for 22% of healthcare costs in 2010, and 5% accounted for 50% of costs.[1] About one-third of this top 5% population in 2010 were also in the top 5% group in 2009.[1] Successful efforts to control healthcare costs must effectively address care for this population.

A substantial portion of costs in these highest risk patient populations may be preventable.[3] Research has found that 8.4% of adult emergency department (ED) visits were preventable,[33] and, within a high-cost Medicare population, that 43% of ED visits were preventable.[2] Prior studies have found that clinical risk,[26-30] self-reported health status,[31,32] and demographic factors (race, socioeconomic status, insurance status)[1,25,33-35] are correlated with high or preventable utilization. Identifying these unmodifiable risk factors does not, however, help to inform the design of interventions to reduce healthcare utilization. Indeed, a comprehensive evaluation of Medicare's six major disease management and care coordination demonstration programs found little or no effect on hospital admissions or net Medicare expenditures.[10]

Measuring patient activation offers one potentially innovative approach to guiding interventions to reduce future utilization.[22] Patient activation is defined as a patient's knowledge, skills, beliefs, and confidence for engaging in self-management behavior, and has been standardized through the 13-item Patient Activation Measure (PAM) (Appendix Table 14).[36] While there is modest evidence that the PAM independently predicts future utilization after controlling for clinical risk, health status, and demographic factors,[37-40] this relationship has not been studied within the high-risk, non-elderly Medicaid population that represents one of the major sources of our nation's health expenditures. We tested the hypothesis that PAM scores predict ED visits in this high-risk population after controlling for clinical severity, self-reported health status, and engagement with healthcare providers.

Methods

Study design

We conducted a retrospective cohort analysis of high-risk Medicaid patients enrolled in a care management program implemented within an integrated health system. The program included assessment of patient activation using PAM surveys. Members were eligible if they were current Kaiser Permanente Northern California (KPNC) Medicaid members and:

1. Had at least 10 months of Medicaid membership, and were not a Medicare member;
2. Were ages 18 through 62;
3. Had two to eight ED visits or hospitalizations (excluding maternity) in the past twelve months or Diagnosis Cost Group (DxCG)[41] prospective score of greater than 3 (4 for the first two enrollment groups); and,
4. Were not a resident of a skilled nursing facility or hospice.

Setting and Participants

KPNC is a nonprofit, integrated healthcare delivery system providing comprehensive medical care to a diverse population of approximately 3.4 million members. Distribution of patient demographic and socioeconomic factors is similar to that of the area population, except at the extremes of the income distribution.[42] All healthcare utilization is recorded within a comprehensive electronic medical record (EMR).

Our study period begins at the point of completion of the first PAM survey, as early as December 2009, and ends at the time of the patient's death or December 31, 2011, the end of the care management program. We did not track utilization beyond December 2011 because the intensity of interventions was a key covariate that ended at that time.

Our study period is the second phase of the care management program that began 22 months earlier. Care managers at four geographically defined service areas received lists of eligible Medicaid members in February 2008, August 2008, December 2008, June 2009, and December 2009. Care managers enrolled members in the program and completed a baseline patient assessment. Each service area had a dedicated team comprising one registered nurse, two licensed vocational nurses, and one licensed clinical social worker. Beginning in December 2009, all care managers were trained in motivational interviewing and PAM administration. We considered members to be "PAM eligible" if they met the following criteria:

1. Coded as "enrolled" as of or at any time after December 1, 2009; or,
2. Had >=1 intervention or attempted contact after December 1, 2009.

Care managers were instructed to attempt a PAM survey and conduct interventions at least every three months; however, this practice varied. As part of a quality improvement project, care managers administered the PAM by phone, occasionally in person, and by mail before any care

management intervention. Many care managers followed up with members after a hospitalization or ED visit. Members received a $10 gift card for completing their first PAM survey.

Sources of Analytic Variables

We obtained age, gender, date of death, membership status, and home zip code from KPNC membership files; and obtained race/ethnicity, spoken language, smoking status, disability, and body mass index (BMI) from the EMR. Chronic conditions (e.g. hypertension, diabetes, asthma, heart failure, and depression) were identified using KPNC's population care registry archives, which are updated quarterly. For socioeconomic status (SES), we obtained zip code-level poverty rate, median household income, high school graduation rate, and college graduation rate from the United States Census Bureau's 2007-2011 American Community Survey (ACS). We created a binary pregnancy variable if a member had any maternity hospital encounters from September 2009 through June 2012.

When attempting to enroll members, care managers asked about working status, informal (non-health care provider) support system ("none", "some", or "significant"), and substance use; or, care managers assessed these three variables from a chart review. Care managers also administered a six-item intake questionnaire (Appendix Table 16) on experience of care and health status (with wording very similar to the first question on the SF-36 survey, with identical response categories).[43]

We created variables for the number of unique case management intervention days six months and twelve months before each analysis interval (see Appendix Table 20 for summary of interventions by type). Because members might have different ED visit rates based on the intensity of the pre-PAM intervention, we created variables for the number of intervention days and for the elapsed time from first program intervention to the first PAM survey.

Clinical risk and utilization

For clinical risk of hospitalization, we used a validated predictive model that incorporates age, gender, diagnostic information and the key lab results.[27] This measure has higher predictive value than the DxCG by making use of lab result information not easily available in systems without an integrated EMR.

We used hospital days and ED visits in the previous year as covariates to control for baseline differences among members. We created variables for the total number of hospital days for each member during the six months and one year before the start of each analysis interval. We created variables for the total number of ED visits six months and twelve months before each member's inclusion on one of the five enrollment lists, and six and twelve months before each member's first PAM survey. Hospitalizations, excluding maternity and psychiatry, and ED visits include care at KPNC and outside facilities and were collected from the EMR and outside billing records.

Engagement proxies

To explore whether the predictive value of the PAM could be achieved through simpler methods, we created variables that could be substitutes for patient activation. We included the intake question "Does your physician understand your healthcare needs?" because prior research has shown that PAM score was strongly associated with the Roter Doctor-patient Communication Scale.[44] We included the support system assessment because of the possible overlap with the PAM construct. We also included whether a member was enrolled in another care management program, had a primary care physician (PCP), had a visit with this PCP during the previous two years, and whether a member had the same PCP during the previous twelve months, because prior research has demonstrated the link between PCP relationship and higher quality of care.[45] The EMR includes a web-based member portal, KP.org, which allows members to view components

of medical records online and to securely email with their physician. We created variables for the total number of logins to KP.org, and total number of sent and read messages.

PAM Score and Level

Raw scores for the PAM are calculated by assigning the values of 1-4 to responses from Disagree Strongly to Agree Strongly: patients are less likely to agree with each successive item in the survey (Appendix Table 14). A Rasch scoring table converts curvilinear summated raw scores to linear, interval scores in the range of 0 (lowest activation) to 100 (highest activation). Patients are classified into four activation levels (1=lowest activation, 4= highest activation) based on their score (Appendix Figure 5). The four-level structure was based on theory and psychometric properties from the PAM's original development.[23] This structure was confirmed in subsequent psychometric research as different versions of a three-level structure.[46,47]

Outcome measure: ED visits

Our primary outcome was the number of ED visits and time to ED visits during the follow-up period.

Statistical analysis

We calculated the annualized ED visit rate per time at-risk by patient characteristics. We categorized the annualized ED visit rate into five groups: 0, >0-1, >1-2, >2-3, and >3 ED visits per year. Time at-risk is the duration from the first PAM survey to the study end date (or patient death). Patients were not at-risk for ED visits during a hospitalization. To test for differences in covariates by ED visit rate category, we used χ^2 tests for categorical variables and Kruskal-Wallis tests for continuous variables. We present the first PAM survey Level by patient characteristic, testing for differences using χ^2 tests and Kruskal-Wallis tests.

We used a conditional recurrent event gap time (GT) model to examine unadjusted and adjusted relationships between time to all ED visits during the follow-up period and PAM, demographic, health status, health condition, clinical risk, prior utilization, study characteristics (e.g. date list released to care managers, time from enrollment to first PAM), and engagement variables. In the GT model, a member was only at risk for a subsequent event after a prior event had occurred.[52] Follow-up time was measured as the days since the previous ED visit, and was reset to zero after each ED visit. A stratum variable indicated the specific ED visit for which a member was at risk. Because participants completed multiple PAM surveys, and because key covariates changed over time, we used the counting process style of input to represent time-dependent repeating covariates. We created a new dataset record for each follow up PAM survey, for each ED visit, and for each hospitalization, and created new values for the following covariates that could have changed: intervention days, clinical risk score, hospital days, PCP, PCP visit, PCP change status, smoking, BMI, other care management, and chronic conditions. Each time-dependent covariate was represented with its value in the month of the start time for each at-risk period, or its most recent value before that month. A patient's observation was censored on the date of death. Because we did not have reliable information on disenrollment, no participants were censored for loss to follow-up.

We included all variables with p-values lower than 0.25 in the univariate analyses in the initial multivariable analyses. We did not include age and gender because they were already included in the clinical risk score. We kept variables in the multivariable models with p-values <0.10, if they caused significant confounding or they improved model fit. We retained race/ethnicity in the models to permit exploration of PAM interactions. We categorized continuous variables, or combined categories, based on linear Wald hypothesis tests. We explored PAM as a continuous variable, and according to the predefined four PAM Levels. We explored interactions between

the three key predictor variables – PAM, clinical risk, self-reported health status – and all other significant covariates on the outcome.

Because the hazards for ED visits appeared non-proportional over time, interactions of some covariates with the log of analysis time were included in the models to adjust for this time dependence. Because they were highly influential on the statistical significance of some of the estimated regression coefficients, the three extreme outliers with very high ED visit rates were excluded from the regression analysis. We also checked for multicollinearity and made appropriate adjustments.

For the subgroup analyses, we explored the effect of a change in PAM score (in continuous and quartile form) for participants with multiple PAM surveys, and explored the effect of pregnancy for female participants. For sensitivity analyses, we tested a variety of final models with different combinations of covariates and specification of variables. For the approximately 1% of patients with missing values on some intake questions, we created a response level for "unknown," and used linear Wald tests to decide whether to combine "unknown" with other categories.

Analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, North Carolina). The KPNC and Johns Hopkins Bloomberg School of Public Health IRBs approved this study.

Results

Study Participants

Of the 2,973 members selected for the care management program, 1,254 did not enroll, were excluded by care managers or could not be reached (Figure 2). An additional 40 members were initially enrolled, but were dis-enrolled before December 2009 and received no additional interventions or attempted contacts. Of the 1679 members who were enrolled in the program, 1,041 completed at least one PAM survey and are the subject of our analysis ("PAM cohort"). In these patients, the median (interquartile range) follow-up time was 570 days (458-642), and all

but four follow-up times were greater than six months. The overall study participation rate (PAM completion/PAM eligible) was 62%.

PAM eligibles were different from the PAM ineligibles (Table 1, all $p \leq 0.01$) by being more female, much less Hispanic and much more African-American, with slightly lower SES (higher poverty rate and lower college graduation rate), and more obese. PAM eligibles had higher rates of asthma, hypertension, diabetes/cardiovascular disease, slightly lower DxCG scores, and higher prior ED visit rates, and closer engagement with PCPs.

PAM cohort patients had a mean age of 38 years, were 84% female, and were 20% Hispanic, 45% African-American and 26% white. Program enrollees who completed at least one PAM differed in several ways from program enrollees without surveys (Table 1, all $p \leq 0.05$): they were more likely to be female (84% versus 78%), much less Hispanic and more African-American, with lower SES (17.1% versus 16.2% poverty rate; 23.5% versus 24.8% college graduation rate). Clinically, the PAM cohort was less disabled (38% versus 45%), more likely to be pregnant (17% versus 10%), and had lower DxCG scores (4.6 versus 5.3), and fewer previous hospital days (1.2 versus 1.7). PAM participation rates were lower for the first three cohorts enrolled in the case management program (55%, 57%, and 56%) and much higher for the last cohort (93%). The PAM cohort was less likely to have a significant support system (25% versus 39%).

Thirty-seven percent of PAM cohort participants were in the lowest two PAM Levels (Table 5). Lower activation patients were older ($p<0.01$), and had lower health status ($p<0.01$), higher disability rates ($p<0.01$), higher depression rates ($p<0.01$), higher hypertension rates ($p=0.04$), higher ED visit rates ($p<0.01$), and lower reported rates of their physicians understanding their healthcare needs ($p=0.01$). A total of 88% of subjects completed at least two PAM surveys, 63% completed at least four, and the median (interquartile range) of time to second PAM survey was 98 days (90-154) (Appendix Table 15).

ED Visits

The study cohort had a total of 3,241 ED visits during the follow-up period and 1,550 person-years at-risk for an event rate of 2.1 ED visits/person-year. Excluding the three extreme outliers (0.2% of the study population) with very high ED visit rates (75, 124, and 234 visits during the follow-up period), the study group had a total of 2,808 ED visits for an event rate of 1.8/person-year. Thirty percent had no ED visits and 20% had only one (Appendix Table 18). Patients with higher ED visit rates were different by race (with an inconsistent pattern), and had higher rates of depression and asthma, much higher hospitalization risk, much higher previous ED utilization, and lower PAM scores (Table 6, all $p \leq 0.05$).

In univariate analysis, being in the lowest activation level (PAM Level 1) was associated with a small increase in ED visit risk (HR: 1.13 [90% CL 1.03-1.24]) (Table 7).

In multivariable regression the effects with the largest magnitude on future ED visit risk were hospitalization risk (HR for 4th quintile: 1.59 [90% CL 1.39-1.82], HR for 5th quintile: 1.71 [90% CL 1.45-2.01]) and baseline ED visits (3-7 ED visit HR: 1.97 [90% CL 1.75-2.22], 8+ ED visit HR: 3.24 [90% CL 2.70-3.88]). PAM was significantly correlated with ED visit risk only among patients who changed PCPs (Table 8). This correlation was limited to patients at PAM Level 1. Being in PAM Level 1 and not having a stable PCP relationship was associated with 40% higher ED risk ($p<0.01$), particularly among African-American (HR: 1.45, $p<0.01$) and Hispanic patients (HR: 1.47, $p=0.05$) (although the sample sizes in these two-way interaction subgroups were small). Being in PAM Level 1 and of "other" race (mostly Asian) was associated with lower ED visit risk, however this effect was strongly influenced by a very small number of extreme observations.

Alternative model specifications produced similar coefficients for PAM, clinical risk, and health status. In the analysis of the subgroup of patients with more than one PAM survey (n=915), we

found that change in PAM score from the most recent previous survey was not related to ED visit risk.

Discussion

We studied whether the PAM independently predicted ED visits in a high-risk Medicaid population. We found an independent association between PAM Level 1 (lowest activation) and ED visit risk among the 15% of participants without stable PCP relationships. These results suggest that PAM could be used to identify patients with higher and modifiable ED visit risk within a broader population of high-risk patients. Moreover, potential interventions to reduce ED visit risk could include efforts to increase PAM and changes to ensure a more stable PCP relationship.

This study expands on previous literature by examining PAM and utilization within a little studied and high-cost patient population. We also had rich clinical data and detailed information on utilization and its timing. Previous studies have found significant relationships across all subgroups of patients between PAM and ED visits, but those studies focused on older populations with diabetes or heart failure,[37,39] or a very large sample of a high-PAM-score population served by a large health system.[38] Our results are similar to the PAM diabetes study that found increased odds of one ED visit between PAM Level 1 and 4 (OR = 1.8, 95% CL 1.4-2.2), but no significant differences among Levels 2, 3 and 4.[39] Our patient population had much lower activation scores than a nationally representative sample: 37% were in the lowest two activation levels compared to 21% nationally, and only 30% were in the highest level compared to 41% nationally.[49] Our results could also be different because of systematic differences between KPNC's integrated delivery system and the other environments where PAM has been studied.

A central question for operational and clinical leaders is whether PAM or other patient-centered assessments provide a useful guide to clinical intervention. Does PAM help identify which high-

risk patients need intervention and which do not? From the Physician Group Practice Demonstration (PGPD)[50] to Accountable Care Organizations (ACOs), federal policy aims to give integrated delivery systems the opportunity and incentive to improve patient well being at the lowest per capita cost. To improve the cost-effectiveness of care management, patients at lower levels of activation might receive higher intensity interventions aimed at building a belief that what they do matters for their health, and patients at higher levels of activation might receive lower intensity, and less expensive interventions, aimed at assisting them in staying on track during times of stress. One large quasi-experimental study has provided some positive evidence that this tailoring approach works to improve outcomes and reduce utilization, but only for an employed population.[21] A randomized study of a diabetes peer-coaching intervention found that the intervention only had impact among patients with low or moderate baseline self-management skills; patients with high self-management skills improved equally with and without intervention.[51] This intervention-tailoring approach is probably more effective in improving behavior sensitive outcomes, such as this study's ED visit rate.

The results of this study need to be interpreted within the limits of the study design. As an observational study, it is subject to unmeasured confounding and causality cannot be determined. In particular, to the extent that the care management intervention was effective, it could have dampened the association between PAM and ED visits. However, with the exception of direct measurement of SES, rigorous measurement of social support, and health literacy, our data set was both rich and complete with a sophisticated clinical risk predictor, detailed measurement of chronic conditions, complete historic utilization information, self-reported health status, and measures that could serve as proxies for patient engagement. In our model, it is likely that race is functioning as a proxy for unmeasured variables. We also use statistical methods to maximize the information from our data: time-to-event conditional recurrent event models. However, our modest sample size limits our ability to detect smaller effects. Our study population is reasonably

representative of the high-risk Medicaid group from which it was drawn, although bias is difficult to assess because of inconsistent effort to reach all potential participants. The apparently lower clinical risk in our study population compared to patients who did not complete at least one PAM survey is probably related to the underlying program design and not to biased selection. A disproportionately small, and possibly lower risk, group of Hispanic patients participated in the study, possibly because of language barriers.

We found associations between decreased PAM and increased ED visit risk among subgroups of patients. The other factors we found to be highly associated with ED visit risk are not easily modifiable. Future randomized intervention studies are needed to test whether customizing interventions to patient activation levels can cost-effectively improve preventable utilization and behavior-sensitive outcomes.

Table 5: PAM Level by Patient Characteristics

Member Characteristics (month of first PAM survey unless otherwise specified)	PAM Level from First Survey					
	1 N=179 (17%)	2 N=212 (20%)	3 N=303 (29%)	4 N=347 (33%)	P value	All N=1041 (100%)
Socio-Demographic						
Mean Age	40.2	39.7	38.0	36.5	0.00	38.2
Gender, male	32 18%	38 18%	43 14%	51 15%	0.60	164 16%
Race						
Hispanic	29 16%	45 21%	54 18%	82 24%	0.28	210 20%
African-American	79 44%	89 42%	141 47%	161 46%		470 45%
Other	14 8%	21 10%	30 10%	25 7%		90 9%
White non-Hispanic	57 32%	57 27%	78 26%	79 23%		271 26%
Language, Spanish	3 2%	9 4%	10 3%	14 4%	0.50	36 3%
Home Medical Center						
East Bay	24 13%	43 20%	70 23%	110 32%	0.00	247 24%
Napa/Solano	36 20%	56 26%	82 27%	88 25%		262 25%
North Valley	80 45%	62 29%	72 24%	74 21%		288 28%
South Sacramento	39 22%	51 24%	79 26%	75 22%		244 23%
Health Status and Conditions						
Health Status: Very good/excellent (11 missing) (at enrollment)	16 9%	26 12%	59 19%	98 28%	0.00	199 19%
Current smoker	57 32%	63 30%	86 28%	83 24%	0.35	289 28%
Morbidly obese	46 26%	56 26%	62 20%	70 20%	0.30	234 22%
Disabled (at enrollment)	95 53%	96 45%	106 35%	102 29%	0.00	399 38%
Pregnancy (% of females)	19 13%	32 18%	42 16%	58 20%	0.41	151 17%
Depression registry	99 55%	93 44%	102 34%	105 30%	0.00	399 38%
Hypertention registry	76 42%	77 36%	88 29%	101 29%	0.03	342 33%
Heart Failure registry	6 3%	13 6%	10	8 2%	0.13	37 4%
Diabetes/Cardiovascular registry	55 31%	65 31%	70 23%	64 18%	0.01	254 24%

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 5 (continued): PAM Level by Patient Characteristics

Member Characteristics (month of first PAM survey unless otherwise specified)	PAM Level from First Survey								P value	All	
	1 N=179 (17%)		2 N=212 (20%)		3 N=303 (29%)		4 N=347 (33%)			N=1041 (100%)	
Clinical Risk and utilization											
Hospitalization risk, mean	7.8%		7.8%		6.0%		5.1%		0.00	6.4%	
ED Visits (prior 12 months), mean	2.1		2.4		2.3		2.0		0.00	2.2	
>=7 Hospital days (prior 6 months)	3	2%	5	2%	6	2%	3	1%	0.54	17	2%
Study Characteristics											
Intervention Days (prior 6 months), mean	3.8		2.9		3.2		3.3		0.04	3.2	
Engagement/Activation Proxies											
Significant Support System, (7 missing) (at enrollment)	27	15%	45	21%	86	28%	98	28%	0.01	256	25%
Enrolled in care management	10	6%	18	8%	23	8%	20	6%	0.55	71	7%
PCP visit in the last two years	172	96%	195	92%	275	91%	311	90%	0.90	953	92%
PCP changed or added in last 12 months	21	12%	31	15%	39	13%	61	18%	0.29	152	15%
Read secure messages prior 12 months, mean	2.0		2.1		2.5		2.3		0.76	2.2	
MD understanding: v good/excellent (46 missing) (at enrollment)	84	47%	111	52%	149	49%	230	66%	0.01	574	55%

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 6: Annualized ED visit rate by Patient Characteristics

Member Characteristics (month of first PAM survey unless otherwise specified)	ED Visit rate (ED Visits/year of at-risk time)											
	0 N=310 (30%)		>0-1 N=184 (18%)		>1-2 N=228 (22%)		>2-3 N=122 (12%)		3+ N=197 (19%)		P value	All N=1041 (100%)	
Socio-Demographic													
Mean Age	38.1		38.1		37.8		38.0		39.1		0.85	38.2	
Gender, male	57	18%	33	18%	26	11%	26	21%	22	11%	0.05	164	16%
Race													
Hispanic	81	26%	31	17%	42	18%	20	16%	36	18%	0.01	210	20%
African-American	128	41%	90	49%	107	47%	62	51%	83	42%		470	45%
Other	39	13%	11	6%	16	7%	7	6%	17	9%		90	9%
White non-Hispanic	62	20%	52	28%	63	28%	33	27%	61	31%		271	26%
Language, Spanish	18	6%	9	5%	7	3%	0	0%	2	1%	0.01	36	3%
Home Medical Center													
East Bay	84	27%	48	26%	58	25%	23	19%	34	17%	0.14	247	24%
Napa/Solano	85	27%	55	30%	53	23%	24	20%	45	23%		262	25%
North Valley	78	25%	43	23%	62	27%	49	40%	56	28%		288	28%
South Sacramento	63	20%	38	21%	55	24%	26	21%	62	31%		244	23%
Health Status and Conditions													
Health Status: Very good/excellent (at enrollment)	67	22%	42	23%	44	19%	18	15%	28	14%	0.20	199	19%
Current Smoking Status	76	25%	56	30%	68	30%	37	30%	52	26%	0.66	289	28%
Morbidly obese	59	19%	33	18%	59	26%	28	23%	55	28%	0.13	234	22%
Disabled (at enrollment)	116	37%	65	35%	83	36%	51	42%	84	43%	0.72	399	38%
Pregnancy (% of females)	38	15%	26	17%	34	17%	13	14%	40	23%	0.32	151	17%
Depression registry	93	30%	75	41%	85	37%	52	43%	94	48%	0.03	399	38%
Asthma registry	73	24%	55	30%	75	33%	41	34%	77	39%	0.03	321	31%
Hypertention registry	84	27%	60	33%	78	34%	50	41%	70	36%	0.19	342	33%
Heart Failure registry	7	2%	3	2%	9	4%	5	4%	13	7%	0.07	37	4%
Diabetes/cardiovascular registry	64	21%	41	22%	52	23%	35	29%	62	31%	0.12	254	24%

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 6 (continued): Annualized ED visit rate by Patient Characteristics

Member Characteristics (month of first PAM survey unless otherwise specified)	ED Visit rate (ED Visits/year of at-risk time)										P value	All	
	0 N=310 (30%)		>0-1 N=184 (18%)		>1-2 N=228 (22%)		>2-3 N=122 (12%)		3+ N=197 (19%)			N=1041 (100%)	
Clinical Risk and utilization													
Hospitalization risk, mean	4.8%		4.9%		5.7%		6.9%		10.7%		0.00	6.4%	
ED Visits prior 12 months													
0	177	57%	84	46%	83	36%	15	12%	26	13%	0.00	385	37%
1-2	104	34%	74	40%	92	40%	68	56%	45	23%		383	37%
3-7	28	9%	24	13%	50	22%	34	28%	92	47%		228	22%
8+	1	0%	2	1%	3	1%	5	4%	34	17%		45	4%
>=7 Hospital days, prior 6 months	7	2%	1	1%	1	0%	4	3%	4	2%	0.18	17	2%
Study Characteristics													
Intervention days, prior six months, mean	3.0		3.1		3.1		3.3		3.8		0.25	3.2	
Engagement/Activation Proxies													
PAM Level, first survey													
1st	46	15%	22	12%	39	17%	32	26%	40	20%	0.04	179	17%
2nd	58	19%	31	17%	49	21%	25	20%	49	25%		212	20%
3rd	96	31%	61	33%	61	27%	32	26%	53	27%		303	29%
4th	110	35%	70	38%	79	35%	33	27%	55	28%		347	33%
Significant Suppt. System (at enrollment)	93	30%	46	25%	49	21%	24	20%	44	22%	0.18	256	25%
Enrolled in care management	12	4%	12	7%	16	7%	9	7%	22	11%	0.05	71	7%
PCP visit in the last two years	275	89%	170	92%	209	92%	113	93%	186	94%	0.98	953	92%
PCP changed or added in last 12 months	44	14%	27	15%	27	12%	19	16%	35	18%	0.62	152	15%
Read secure messages prior 12 months, mean	1.6		2.5		2.3		1.5		3.5		0.37	2.2	
MD understanding: v good/excellent (at enrollment)	175	56%	90	49%	129	57%	68	56%	112	57%	0.81	574	55%

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 7: Unadjusted and Adjusted Cox Proportional Hazards Estimates: Time to ED Visits

	Unadjusted		Adjusted	
	HR	**90% CI**	**HR**	**90% CI**
Race				
Hispanic	0.84 [1]	(0.75 - 0.94)	See interaction table	
African-American	0.91	(0.84 - 0.98)		
Other	1.05	(0.87 - 1.27)		
White non-Hispanic	ref			
Language				
Not Spanish	ref		ref	
Spanish	0.56	(0.42 - 0.74)	0.62	(0.47 - 0.82)
Home service area				
East Bay	ref		ref	
Napa	1.06 [2]	(0.95 - 1.19)	1.01 [2]	(0.90 - 1.13)
North Valley	1.13 [2]	(1.02 - 1.25)	1.06 [2]	(0.95 - 1.19)
South Sacramento	1.26	(1.13 - 1.40)	1.33	(1.19 - 1.49)
Hypertension				
Not in registry	ref		ref	
In registry	1.14	(1.06 - 1.22)	0.87	(0.79 - 0.94)
Hospitalization risk, quintile				
1st	ref		ref	
2nd	1.22 [3]	(1.08 - 1.37)	1.15 [3]	(1.02 - 1.29)
3rd	1.46 [4]	(1.30 - 1.64)	1.34 [4]	(1.19 - 1.51)
4th	1.81	(1.60 - 2.03)	1.59	(1.39 - 1.82)
5th	2.03	(1.76 - 2.35)	1.71	(1.45 - 2.01)
Hospital days, 6 mo before				
0-6	ref		ref	
>= 7	1.54	(1.30 - 1.83)	1.36	(1.14 - 1.63)
ED visits, 12 mo before first PAM				
0	ref		ref	
1-2	1.37 [5]	(1.21 - 1.54)	1.34 [5]	(1.20 - 1.50)
3-7	2.14 [5]	(1.89 - 2.43)	1.97 [5]	(1.75 - 2.22)
8+	3.60 [5]	(2.98 - 4.35)	3.24 [5]	(2.70 - 3.88)
Interventions, 6 mo before (at mean=6)	1.10	(1.06 - 1.14)	1.05	(1.01 - 1.10)
PAM Level				
Level 1	1.13	(1.03 - 1.24)	See interaction table	
Level 2, 3, or 4	ref			
Support system				
Some/none	ref		ref	
Significant	0.93	(0.85 - 1.01)	0.89	(0.82 - 0.98)
PCP change status last 12 months				
Same PCP	ref		See interaction table	
Changed, added, or no PCP	1.17	(1.06 - 1.29)		

Note: Comparisons use 90% 2-sided Wald robust CIs. Estimates centered at follow-up time of 68 days.

[1] significantly lower than Other Race

[2] significantly lower than South Sacramento

[3] significantly lower than quintiles 3, 4, and 5

[4] significantly lower than quintiles 4 and 5

[5] significantly different from all other ED levels

Table 8: Adjusted ED Visit Hazard Ratios for Patients with last PAM score Level 1 versus Levels 2, 3, or 4 by Race and PCP Change Status

Race	PCP Change Status Last 12 Months					
	No PCP change		Changed, added, or no PCP		All	
	HR	90% CI	HR	90% CI	HR	90% CI
	Model 1: PCP Change and Race interactions				**Model 2: Race interaction only**	
African-American	0.97	(0.85 - 1.11)	1.45 ***	(1.21 - 1.73)	1.06	(0.94 - 1.20)
Hispanic	0.99	(0.73 - 1.34)	1.47 **	(1.07 - 2.03)	1.03	(0.76 - 1.38)
Other	0.68 ***	(0.52 - 0.87)	1.01	(0.73 - 1.40)	0.73 *	(0.55 - 0.97)
White non-Hispanic	0.83	(0.67 - 1.02)	1.23	(0.96 - 1.58)	0.88	(0.72 - 1.08)
	Model 3: PCP Change interaction only				**Model 4: no interactions**	
All	0.94	(0.84 - 1.05)	1.40 ***	(1.19 - 1.65)	1.01	(0.91 - 1.12)

$^{***}p<0.01$ (for difference from 1.0) $^{**}p<0.05$ $^{**}p<0.10$

Model 1. Adjusted Multivariable Model with two, two-way interactions: PAMlevel1*race and PAMlevel*pcpchange.

$$\log(HR) = b_1\text{PAMlevel1}+..+b_2\text{black} + b_3\text{hispanic} + b_4\text{other} +....+b_5\text{pcpchange} + b_6\text{PAMlevel1}\cdot\text{black}+ b_7\text{PAMlevel1}\cdot\text{hispanic} + b_8\text{PAMlevel1}\cdot\text{other} + b_9\text{PAMlevel1}\cdot\text{pcpchange}$$

Model 2. Adjusted Multivariable Model with one, two-way interaction: PAMlevel1*race.

$$\log(HR) = b_1\text{PAMlevel1}+..+b_2\text{black} + b_3\text{hispanic} + b_4\text{other} +.... + b_5\text{pcpchange} + b_6\text{PAMlevel1}\cdot\text{black}+ b_7\text{PAMlevel1}\cdot\text{hispanic} + b_8\text{PAMlevel1}\cdot\text{other}$$

Model 3. Adjusted Multivariable Model with one, two-way interaction: PAMlevel1*pcpchange.

$$\log(HR) = b_1\text{PAMlevel1}+..+b_2\text{black} + b_3\text{hispanic} + b_4\text{other} +....+b_5\text{pcpchange} + b_6\text{PAMlevel1}\cdot\text{pcpchange}$$

Model 4. Adjusted Multivariable Model with no interactions.

$$\log(HR) = b_1\text{PAMlevel1}+..+b_2\text{black} + b_3\text{hispanic} + b_4\text{other} +....+b_5\text{pcpchange}$$

Manuscript III: The longitudinal effect of a motivational interviewing intervention on patient activation

Importance: Motivational interviewing (MI) is a promising strategy for improving self-management and behavior-sensitive outcomes, but it is unclear how to optimize its effectiveness.

Objective: To examine the effect of an MI intervention, and variation in its intensity and type, on Patient Activation Measure (PAM) score changes among high-risk Medicaid patients cared for within an integrated health delivery system.

Design: Retrospective cohort study from December 2009 through December 2011.

Setting: Four medical centers within Kaiser Permanente Northern California (KPNC).

Participants: We studied 915 high-risk Medicaid patients aged 18-62 years who had at least 10 months of KPNC membership, lived at home, completed two or more PAM surveys, and were enrolled in a MI program. High risk was defined as 2-8 emergency department (ED) visits or hospitalizations in the prior year or Diagnosis Cost Group (DxCG) score of >= 3.

Main Outcome Measure: PAM score change.

Results: Participants were typical of non-elderly, high-cost California Medicaid patients: mean age, 38 years; 85% female; 20% Hispanic; 46% African-American; 23% morbidly obese; 39% disabled. Participants completed a median (interquartile range) of 4 surveys (3-5), and the median (interquartile range) time from first to last PAM was 379 days (267-483). The mean first PAM score was 60.8 and the unadjusted change from first to last score was a clinically meaningful increase of 4.1 points ($p<0.01$). There was an average of 1.8 interventions/month before each PAM survey, 0.8 of which were coaching-style interventions. In multivariable regression, intervention quantity was unrelated to PAM score change. However, lower activation patients received the most interventions (PAM Level 1: 2.5/month; Level 2: 1.9/month; Level 3:

1.7/month; Level 4: 1.5/month; χ^2 $p<0.01$) and improved their PAM scores the most between subsequent surveys (adjusted GEE PAM score change for Level 1 versus Level 4 at mean of interaction variables: 12.7 points; Level 2 versus Level 4: 11.9 points; Level 3 versus Level 4: 8.6 points; all $p<0.01$).

Conclusions and Relevance: MI interventions within a high-risk Medicaid population were associated with clinically meaningful improvements in patient activation, especially among lower activation patients. Tailored MI intervention is a potentially cost-effective approach for increasing patient activation.

Introduction

In 2006, 28% of Americans had two or more chronic conditions and this group accounted for almost 2/3rds of healthcare spending.[4] People with five or more chronic conditions account for two-thirds of Medicare spending.[4] Substantial efforts have been focused on identifying interventions within this high-risk population that can reduce future costs.

Behavioral factors highly influence preventable deaths in the United States.[53] Living well with chronic disease requires significant self-care behavior, and evidence-based models of chronic disease care[5,54-56] and federal policy[57] have emphasized the importance of patient self-management support.

Motivational interviewing (MI) is a promising approach for improving self-care behaviors and "acknowledges the patient's expertise into his or her own problems and empowers the patient to develop his or her own motivation."[16] Recent meta-analyses found that motivational interviewing, including brief intervention, improved self-efficacy, engagement, health behaviors, medication adherence, clinical markers, and quality of life.[16-18] However, MI's cost-effectiveness is less clear.[19,20] Tailoring MI to patients with the greatest opportunity to improve their self-management skills could be a cost-effective strategy.

Measuring patient activation offers one potentially innovative approach for targeting interventions to patients who can benefit the most, and for tracking the effectiveness of interventions in improving self-management.[22] Patient activation is defined as a patient's beliefs, knowledge, and skills for engaging in self-management behavior, and has been standardized through the 13-item Patient Activation Measure (PAM) (Appendix Table 14).[36]

A variety of interventions have produced statistically and clinically significant changes in PAM scores including: brief intervention in a community health center;[58] video motivational programs at senior centers;[59] variants of the Chronic Disease Self-Management Program[60] with an insured chronic disease population,[61] a serious mental illness population,[62] and community-based diabetes population;[63] a PAM-level tailored MI intervention in a disease management program,[21] participatory decision making in primary care practices,[64] a tailored coaching intervention with heart failure patients,[37] and web-based patient portals in primary care practices.[65,66]

Despite the evidence that PAM scores can be improved and are associated with positive behaviors and clinical outcomes, it is unclear which interventions are most effective within different patient sub-groups. This study examines the extent to which variations in the intensity and content of a MI intervention in a high-utilizing, high chronic condition Medicaid population are associated with changes in patient activation.

Methods

Study design

We conducted a retrospective cohort analysis of high-risk Medicaid patients enrolled in a care management program implemented within an integrated health system. The program included assessment of patient activation using PAM surveys. Members were eligible if they were current Kaiser Permanente Northern California (KPNC) Medicaid members and:

1. Had at least 10 months of Medicaid membership, and were not a Medicare member;

2. Were 18 through 62;
3. Had two to eight ED visits or hospitalizations (excluding maternity) in the past twelve months or Diagnosis Cost Group (DxCG)[41] prospective score of greater than 3 (4 for the first two enrollment groups); and,
4. Were not a resident of a skilled nursing facility or hospice.

Setting and Participants

KPNC is a nonprofit, integrated healthcare delivery system providing comprehensive medical care to a diverse population of approximately 3.4 million members. Distribution of patient demographic and socioeconomic factors is similar to that of the area population, except at the extremes of the income distribution.[42] All healthcare utilization is recorded within a comprehensive electronic medical record (EMR).

Our study period begins at the point of completion of the first PAM survey, as early as December 2009, and ends at the time of the patient's death or the patient's last PAM survey (as late as December 2011).

Our study period is the second phase of the care management program that began 22 months earlier. Care managers at four geographically defined service areas received lists of eligible Medicaid members in February 2008, August 2008, December 2008, June 2009, and December 2009. Care managers enrolled members in the program and completed a baseline patient assessment. Each service area had a dedicated team comprising one registered nurse, two licensed vocational nurses, and one licensed clinical social worker. Beginning in December 2009, all care managers were trained in motivational interviewing and PAM administration. We considered members to be "PAM eligible" if they met the following criteria:

1. Coded as "enrolled" as of or at any time after December 1, 2009; or,
2. Had >=1 intervention or attempted contact after December 1, 2009.

Care managers were instructed to attempt a PAM survey and conduct interventions at least every three months; however, this practice varied. As part of a quality improvement project, care managers administered the PAM by phone, occasionally in person, and by mail before any care management intervention. Many care managers followed up with members after a hospitalization or ED visit. Members received a $10 gift card for completing their first PAM survey.

Sources of Analytic Variables

We obtained age, gender, date of death, membership status, and home zip code from KPNC membership files; and obtained race/ethnicity, spoken language, smoking status, disability, and body mass index (BMI) from the EMR. Chronic conditions (e.g. hypertension, diabetes, asthma, heart failure, and depression) were identified using KPNC's population care registry archives, which are updated quarterly. For socioeconomic status (SES), we obtained zip code-level poverty rate, median household income, high school graduation rate, and college graduation rate from the United States Census Bureau's 2007-2011 American Community Survey (ACS). We created a binary pregnancy variable if a member had any maternity hospital encounters from September 2009 through June 2012.

When attempting to enroll members, care managers asked about working status, informal (non-health care provider) support system ("none", "some", or "significant"), and substance use; or, care managers assessed these three variables from a chart review. Care managers also administered a six-item intake questionnaire (Appendix Table 16) on experience of care and health status (with wording very similar to the first question on the SF-36 survey, with identical response categories).[43]

Because members might have different PAM score changes based on the intensity of the pre-PAM intervention, we created variables for the number of intervention days and for the elapsed time from first program intervention to the first PAM survey.

Clinical risk and utilization

For clinical risk of hospitalization, we used a validated predictive model that incorporates age, gender, diagnostic information and key lab results.[27] We used hospital days and ED visits as covariates to control for baseline differences among members, and ongoing utilization effects on PAM score change. We created variables for hospital days and ED visits for each member six months and one year before the start of each analysis interval. Hospitalizations, excluding maternity and psychiatry, and ED visits include care at KPNC and outside facilities and were collected from the EMR and outside billing records.

Engagement proxies

We used available data to create substitutes for patient activation that could influence improvements in activation. We included the intake questions "Does your physician understand your healthcare needs?" because prior research has shown that the PAM score was strongly associated with the Roter Doctor-patient Communication Scale.[44] We included the support system assessment because of the possible overlap with the PAM construct. We also included whether a member was enrolled in another care management program, had a primary care physician (PCP), had a visit with this PCP during the previous two years, and whether a member had the same PCP during the previous twelve months because prior research has demonstrated the link between PCP relationship and higher quality of care.[45] The EMR includes a member portal, KP.org, which allows members to view components of their medical records, and to securely email with their physician. We created variables for the number of logins to KP.org, and number of sent and read messages.

Outcome measure: change in PAM score

Our primary outcome was the change in PAM score from one survey to the next. Score changes of four points have been associated with clinically meaningful behavior changes.[21] Raw scores

for the PAM are calculated by assigning the values of 1-4 to responses from Disagree Strongly to Agree Strongly: patients are less likely to agree with each successive item in the survey. A Rasch scoring table converts curvilinear summated raw scores to linear, interval scores in the range of 0 (lowest activation) to 100 (highest activation). Patients are classified into four activation levels (1=lowest activation, 4= highest activation) based on their scores (Appendix Figure 5). The four-level structure was based on theory and psychometric properties from the PAM's original development.[23] This structure was confirmed in subsequent psychometric research as different versions of a three-level structure.[46,47]

Intervention covariates

The study tracked 90 different types of interventions (Appendix Table 19). Although the entire program was based on motivational interviewing, many of the interventions were referrals or care coordination that did not focus on patient capabilities or reducing cognitive barriers to self-management. We defined four intervention categories (Appendix Table 20):

1. Coaching (34% of total). Education and patient interaction indicating stronger motivational interviewing content.
2. Non-coaching (36%). Care coordination, referral, and documentation of contacts.
3. Emotional support (15%). Accessing emotional support was explicitly excluded from the original patient activation construct based on patient feedback.[23]
4. Failed outreach (15%). Unsuccessful outreach attempt.

Because almost 75% of the intervals between PAM surveys were less than four months (Appendix Table 15) we chose 120 days as the previous time period for creating intervention (coaching, non-coaching, and the total of both), emotional support, and failed outreach variables. To distinguish intervention intensity from intervention type, we also created a variable for the proportion of total interventions in the last 120 days that involved coaching.

Statistical analysis

We analyzed patient characteristics for participants by only one versus multiple PAM surveys, by PAM Level, and by PAM score change quartile. To explore whether the interventions had differential impacts for patients at different PAM Levels, we calculated means for intervention variables by prior PAM Level and PAM change quartile. We tested for differences between covariates using χ^2 tests for categorical variables and Kruskal-Wallis tests for continuous variables, and used signed rank tests to compare first and last PAM scores.

We used Generalized Estimating Equations (GEE)[67] longitudinal data analysis to model PAM score change as a function of intervention intensity and characteristics controlling for time (days since first PAM survey), demographics, health status, health conditions, clinical risk, prior utilization, study characteristics, last PAM Level, and engagement variables. GEE adjusts for repeated measurements on the same patient. We created a new dataset record for each follow up PAM survey and created new values for the following covariates that could have changed: intervention intensity, coaching intervention share, emotional support, failed outreach, clinical risk score, hospital days, ED visits, PCP, PCP visit, PCP change status, smoking, BMI, other care management, and chronic conditions. Each covariate was represented with its value in the month of the PAM survey, or its most recent value before that month.

We included all variables with p-values lower than 0.25 from univariate analyses in the initial multivariable analyses. We kept variables in the models with p-values <0.05, if they caused significant confounding or they improved model fit. Race/ethnicity and gender were retained in the models to permit exploration of interactions with interventions variables. We categorized continuous variables or combined categories based on linear Wald hypothesis tests, and tested interactions between MI intervention variables and all other covariates. We checked and adjusted for multicollinearity and highly influential observations.

For sensitivity analyses, we tested a variety of final models with different combinations of covariates and specification of variables. For the approximately 1% of patients with missing values on some intake questions, we created a response level for "unknown," and used linear Wald tests to decide whether to combine "unknown" with other categories.

Analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, North Carolina). The KPNC and Johns Hopkins Bloomberg School of Public Health IRBs approved this study.

Results

Study Participants

Of the 2,973 members selected for the care management program, 1,254 did not enroll, were excluded by care managers or could not be reached (Figure 3). An additional 40 members were initially enrolled, but were dis-enrolled before December 2009 and received no additional interventions. Of the 1,679 members who were PAM eligible, 1,041 completed at least one PAM survey, and 915 completed two or more and are the subject of our analysis ("repeat PAM cohort"). The Cronbach's alpha (internal consistency) for the first PAM survey was 0.86. In the repeat PAM cohort, the median (interquartile range) follow-up time, from first to last PAM was 379 days (267-483), and only 25 of the follow-up times were less than 90 days (2.7%). Repeat PAM cohort participants completed a median (interquartile range) of 4 surveys (3-5) and the median (interquartile range) of days between surveys was 95 (88-125) (Appendix Table 15). The overall study participation rate (multiple PAM completion/PAM eligible) was 54%.

Findings on the representativeness of patients who completed at least one PAM survey compared to the full eligible population are reported elsewhere (Table 1 and Table 2 in Manuscript 1). Repeat PAM cohort participants had a mean age of 38 years, and 20% were Hispanic, 46% were African-American and 26% were white (Table 9). Compared to patients who only completed one PAM, repeat PAM cohort participants were more likely to be African-American and less likely to

be of "Other" race, differed slightly by home medical center, and had fewer days from enrollment to first PAM (301 versus 368) (all p values≤0.05). There were no other significant differences.

Thirty-eight percent of repeat PAM cohort participants were in the lowest two PAM Levels for their first survey (Table 9). Lower activation patients were older, less likely to work, and had lower health status, higher disability rates, higher depression rates, higher hospitalization risk, more time from enrollment to first PAM, more intervention days before first PAM, weaker support system, and lower perceived physician understanding of their healthcare needs (all p values≤0.01).

PAM Score Change

PAM scores increased over the entire course of the study (last PAM minus first PAM) by an average of 4.10 points (n=915, p<0.01) and median (interquartile range) of 2.8 (-4.8 – 12.6), with lower activation patients improving the most (first PAM Level 1: +10.4 points; Level 2: +9.0; Level 3: +4.5; Level 4: -2.6; all p-values <0.01). For patients who improved their PAM scores the most (PAM Change Quartile 4), the largest magnitude improvement on particular PAM questions, particularly for lower activation patients, tended to be higher difficulty ones such as "ability to maintain lifestyle changes," "confidence in solving new problems," and "confidence in maintaining lifestyle changes during stress" (Appendix Table 21).

In the analysis of all PAM score changes between subsequent surveys (n=2,855) being in a higher PAM change quartile was associated with higher total intervention rates, higher non-coaching interventions rates, and lower prior PAM Levels (Table 10, all p-values≤0.01). In the analysis of interventions by prior PAM Level (Table 11), within PAM Level 1, a higher coaching share was fairly consistently associated with higher PAM change quartile (p<0.01). Across all intervention types and all intervention subtypes (except for goals and patient meetings), care managers delivered more interventions to patients at lower prior PAM Levels (Total Interventions for prior

PAM Level 1: 2.5/month; Level 2: 1.9/month; Level 3: 1.7/month; Level 4: 1.5/month), particularly prior Level 1 (all p-values≤0.01). Other statistically significant differences were inconsistent in the direction of their relationship with PAM change quartile.

In univariate regression, increasing total interventions by 2.25 (the interquartile range) was associated with a mere 0.4 more points of PAM score change (p=0.05) (Table 12). No other intervention variables were significant in univariate analysis. There was a significant univariate time trend of 1.0 points per 90 days (GEE regression of PAM Score on days since first PAM).

In multivariable regression (Table 12 and Table 13), the non-intervention effects with the largest observed effects on PAM score change were prior PAM Level 1 (10.5 points higher than PAM Level 4 at 25th percentile of coaching share and 14.0 points higher at the 75th percentile), PAM Level 2 (10.4 and 12.7 points higher), prior PAM Level 3 (8.1 and 8.8 points higher), >=10 ED visits (3.1 points lower than <10)), and "Excellent MD Understanding" (2.4 points higher than less than Excellent at 75th percentile of coaching share) (all p-values<0.01). Smaller significant effects (-2 to +2) in predictable directions were associated with age>=50, currently working, current smoker, and significant support system. There was no significant time trend in multivariable regression.

None of the intervention variables, emotional support, or failed outreach had a significant association with PAM score change across all patients, but the coaching share variable had significant effects within patient subgroups. Holding all other variables constant, increasing the coaching share by 0.54 (the size of the interquartile range) among patients who reported "Excellent MD Understanding" was associated with 3.5 more points of PAM score change for a patient starting at Level 1 (p<0.01) and 2.3 more points for a Level 2 patient (p=0.05) (Table 13). Increasing the coaching proportion by 0.54 among patients with below "Excellent MD Understanding" was associated with 1.9 *fewer* points of score change (p=0.03).

Alternative variable transformations and model specifications produced similar coefficients for the significant effects. Using cluster deletion diagnostics, we found a large number of cases with high influence. We tested the model without these cases, and the direction, magnitude and significance of key variables did not change substantially. Our reported results include all cases.

Discussion

We studied whether and how an MI intervention influenced changes in PAM scores over time for a high-risk Medicaid population. PAM scores improved by 4.1 points with improvement concentrated among patients starting at lower activation levels. Activation improvements of this size have been associated with important improvements in patient behaviors.[21] Lower activation patients also received more interventions of all types during the study. Our results suggest that MI can produce important improvements in patient activation in our high-risk Medicaid population.

This study expands on previous literature by examining how natural variation in the application of a MI-based intervention influences PAM score changes in a high-risk, high-chronic condition, low-activation Medicaid population. Similar to other studies, we found larger increases in PAM scores for patients starting at lower activation levels.[21,58,59] This could be caused by regression to the mean, or a ceiling effect, but it is encouraging that low activation patients seem to benefit most from intervention. Although our care managers were not trained to vary their intervention by initial activation level, they provided more interventions to patients at lower activation levels. This is consistent with another MI intervention that intentionally tailored based on PAM,[21] suggesting that MI training, by its very nature, may lead care managers to tailor their work.

Higher coaching content may be especially important for initially low activation patients who report strong MD understanding of their needs. "Excellent MD understanding" might magnify the effect of coaching interventions among low activation patients. Other studies have also found a

positive interaction of PAM and patient-physician understanding or satisfaction.[44,68] There is some suggestive evidence that *non-coaching* interventions sustain activation better among patients with initially high activation and those who did not report "Excellent MD understanding." Possibly, patients who already have strong self-management skills develop and maintain their activation better when a care manager explicitly solves problems (through referral and coordination) that the patient cannot solve alone.

In another study depression was associated with lower PAM scores; we did not find that relationship in our population.[61] Our patient population had much lower activation scores than a nationally representative sample: 38% were in the lowest two activation levels compared to 21% nationally, and only 33% were in the highest level compared to 41% nationally.[49]

A central question for operational and clinical leaders is whether PAM or other patient-centered assessments provide a useful guide to intensity or content of care management interventions. Does PAM help identify which high-risk patients need intervention and which interventions will work? From the Physician Group Practice Demonstration (PGPD)[50] to Accountable Care Organizations (ACOs), federal policy aims to give integrated delivery systems the opportunity and incentive to improve patient well-being at the lowest per capita cost. To make care management cost-effective, patients at lower levels of activation might receive higher intensity interventions aimed at building a belief that what they do matters for their health, and patients at higher levels of activation might receive lower intensity, and less expensive interventions, aimed at assisting them in staying on track during times of stress. A large quasi-experimental study has provided evidence that this tailoring approach works to improve outcomes and reduce utilization for an employed population.[21] A randomized study of a diabetes peer-coaching intervention found that the intervention only had impact among patients with low or moderate baseline self-management skills; patients with high self-management skills improved equally with and without intervention.[51]

The results of this study need to be interpreted within in the limits of the study design. As an observational study, we are subject to unmeasured confounding and cannot determine causality. However, PAM does not usually improve without intervention: with one exception,[61] the control group in randomized studies has not improved by clinically meaningful levels.[21,37,62,63,66] Our finding of a strong association between prior PAM Level and PAM score change could also be caused by the systematic delivery of more interventions to low activation patients, but our study design makes it challenging to separate the causal effects of "last PAM level" and "number of interventions." Our study population is reasonably representative of the high-risk Medicaid group from which it was drawn. The apparently lower clinical risk in our study population compared to patients who did not complete at least one PAM survey is probably related to the underlying study design and not to biased selection. Possibly because of language barriers, a disproportionately small, and possibly lower risk, group of Hispanic patients completed at least one PAM.

We found a clinically meaningful improvement in activation from an MI intervention in a high utilizing Medicaid population. Care managers delivered more interventions to low activation patients. Activation improved the most among patients starting with low activation. Randomized studies of a PAM-tailored MI intervention are needed to develop evidence-based cost-effective strategies for further improving self-management behavior.

Figure 3: Participant Selection: Multiple PAM Survey Analyses

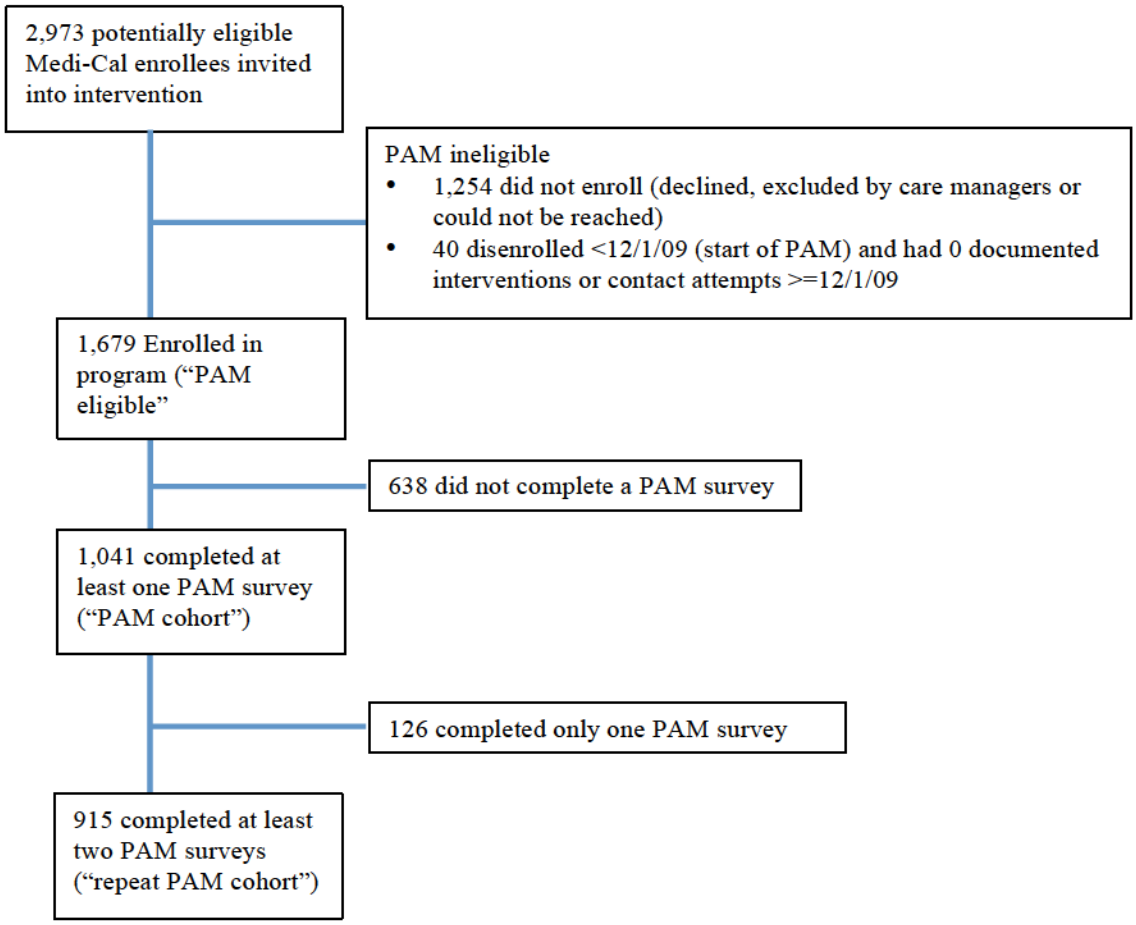


Table 9: Patient Characteristics by Number of PAMs and first PAM Score Level, for patients with multiple surveys

Member Characteristics (month of first PAM survey unless specified)	Number of PAM Surveys During Study							PAM level from first survey if >1 PAM								
	1 PAM N=126 (12%)		>1 PAM N=915 (88%)		All N=1041		P value	1 N=163 (18%)		2 N=182 (20%)		3 N=267 (29%)		4 N=303 (33%)		P value
Socio-Demographic																
Mean Age	36.8		38.4		38.2		0.13	40.5		39.7		38.5		36.5		0.00
Gender, female	99	79%	778	85%	877	84%	0.46	136	83%	150	82%	231	87%	261	86%	0.96
Race																
White non-Hispanic	30	24%	241	26%	271	26%	0.03	51	31%	48	26%	72	27%	70	23%	0.07
African-American	48	38%	422	46%	470	45%		78	48%	75	41%	125	47%	144	48%	
Hispanic	29	23%	181	20%	210	20%		25	15%	40	22%	44	16%	72	24%	
Other	19	15%	71	8%	90	9%		9	6%	19	10%	26	10%	17	6%	
Language, Spanish	3	2%	33	4%	36	3%	0.49	2	1%	8	4%	10	4%	13	4%	0.35
Home Medical Center																
East Bay	29	23%	218	24%	247	24%	0.05	23	14%	34	19%	63	24%	98	32%	0.00
Napa/Solano	20	16%	242	26%	262	25%		33	20%	49	27%	76	28%	84	28%	
North Valley	42	33%	246	27%	288	28%		71	44%	55	30%	62	23%	58	19%	
South Sacramento	35	28%	209	23%	244	23%		36	22%	44	24%	66	25%	63	21%	
Poverty Rate (in home zip)	17.6		16.9		17.0		0.26	16.7		17.2		16.9		16.9		0.95
College graduation rate(in home zip)	23.4		23.5		23.5		0.59	23.1		23.9		23.2		23.8		0.90
Full or part-time work (at enrollment)	35	28%	199	22%	234	22%	0.18	20	12%	33	18%	65	24%	81	27%	0.01
Health Status and Conditions																
Health Status (at enrollment)																
Missing	5	4%	6	1%	11	1%	0.00	0	0%	1	1%	4	1%	1	0%	0.21
Poor	15	12%	108	12%	123	12%	0.71	34	21%	27	15%	28	10%	19	6%	0.00
Fair	34	27%	274	30%	308	30%		70	43%	59	32%	67	25%	78	26%	
Good	45	36%	355	39%	400	38%		45	28%	72	40%	120	45%	118	39%	
Very good	16	13%	119	13%	135	13%		10	6%	16	9%	38	14%	55	18%	
Excellent	11	9%	53	6%	64	6%		4	2%	7	4%	10	4%	32	11%	

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 9 (continued) Patient Characteristics by Number of PAMs and first PAM Score Level, for patients with multiple surveys

Member Characteristics (month of first PAM survey unless specified)	Number of PAM Surveys During Study				PAM level from first survey if >1 PAM				
	1 PAM N=126 (12%)	>1 PAM N=915 (88%)	All N=1041	P value	1 N=163 (18%)	2 N=182 (20%)	3 N=267 (29%)	4 N=303 (33%)	P value
Health Status and Conditions (cont.)									
Smoking Status, current smoker	35 28%	254 28%	289 28%	1.00	53 33%	51 28%	78 29%	72 24%	0.35
BMI category, morbidly obese	24 19%	210 23%	234 22%	0.39	42 26%	47 26%	58 22%	63 21%	0.57
Substance abuse (at enrollment)	15 12%	112 12%	127 12%	0.92	29 18%	26 14%	24 9%	33 11%	0.06
Disabled (at enrollment)	41 33%	358 39%	399 38%	0.26	85 52%	83 46%	100 37%	90 30%	0.00
Depression	43 34%	356 39%	399 38%	0.42	91 56%	80 44%	93 35%	92 30%	0.00
Asthma	34 27%	287 31%	321 31%	0.41	53 33%	63 35%	77 29%	94 31%	0.74
Hypertention registry	38 30%	304 33%	342 33%	0.57	70 43%	65 36%	82 31%	87 29%	0.06
Heart Failure registry	3 2%	34 4%	37 4%	0.46	6 4%	12 7%	9 3%	7 2%	0.12
Diabetes/Cardiovascular	28 22%	226 25%	254 24%	0.60	49 30%	57 31%	64 24%	56 18%	0.02
Clinical Risk and utilization									
Hospitalization risk	6.6%	6.3%	6.4%	0.14	7.9%	7.4%	6.2%	5.0%	0.00
ED visits prior 180 days, annualized	2.1	2.3	2.3	0.18	2.2	2.4	2.5	2.1	0.02
Hosp. days prior 180 days, annualized	0.9	0.8	0.8	0.56	0.8	0.8	0.9	0.6	0.11
Study Characteristics									
Days from enrollment to first PAM	368	301	309	0.04	375	332	294	249	0.00
Intervention days before first PAM	8.0	8.1	8.1	0.77	10.6	7.7	7.3	7.6	0.00
List date									
Feb-08	31 25%	186 20%	217 21%		43 26%	44 24%	50 19%	49 16%	
Aug-08	24 19%	204 22%	228 22%		37 23%	35 19%	60 22%	72 24%	
Dec-08	21 17%	183 20%	204 20%	0.67	27 17%	34 19%	61 23%	61 20%	0.36
Jun-09	23 18%	150 16%	173 17%		29 18%	29 16%	41 15%	51 17%	
Dec-09	27 21%	192 21%	219 21%		27 17%	40 22%	55 21%	70 23%	
Engagement/Activation Proxies									
PAM Score	63.0	60.8	61.0	0.18	41.7	50.2	60.0	78.0	0.00
Total PAM Surveys	1.0	4.1	3.7	0.00	4.1	4.1	4.1	4.2	0.79

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 9 (continued) Patient Characteristics by Number of PAMs and first PAM Score Level, for patients with multiple surveys

Member Characteristics (month of first PAM survey unless specified)	Number of PAM Surveys During Study							PAM level from first survey if >1 PAM								
	1 PAM N=126 (12%)		>1 PAM N=915 (88%)		All N=1041		P value	1 N=163 (18%)		2 N=182 (20%)		3 N=267 (29%)		4 N=303 (33%)		P value
Engagement/Activation Proxies (cont.)																
Support System, at enrollment																
none	11	9%	51	6%	62	6%		16	10%	15	8%	11	4%	9	3%	
some	80	63%	636	70%	716	69%	0.30	122	75%	129	71%	176	66%	209	69%	0.00
significant	31	25%	225	25%	256	25%		24	15%	38	21%	78	29%	85	28%	
Unknown	4	3%	3	0%	7	1%	0.00	1	1%	0	0%	2	1%	0	0%	0.33
PCP visit in the last two years	111	88%	842	92%	953	92%	0.67	157	96%	169	93%	246	92%	270	89%	0.89
PCP changed/added/none last 12 mos.	18	14%	134	15%	152	15%	0.92	21	13%	24	13%	34	13%	55	18%	0.28
Sent messages in last 12 mos.	1.4		2.2		2.1		0.47	2.1		1.9		2.6		2.1		1.00
MD understanding of needs (at enroll)																
Unknown	9	7%	37	4%	46	4%	0.12	5	3%	4	2%	15	6%	13	4%	0.31
poor	8	6%	33	4%	41	4%		8	5%	6	3%	13	5%	6	2%	
fair	9	7%	90	10%	99	10%		28	17%	13	7%	27	10%	22	7%	
good	34	27%	247	27%	281	27%	0.53	46	28%	59	32%	83	31%	59	19%	0.00
very good	31	25%	233	25%	264	25%		43	26%	54	30%	59	22%	77	25%	
excellent	35	28%	275	30%	310	30%		33	20%	46	25%	70	26%	126	42%	

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 10: Patient Characteristics by Quartile of PAM Score Change from Last PAM Survey

Member Characteristics (month of the PAM survey unless specified)	Quartile of PAM score change from last survey											
	< - 6.5 N=715 (25%)		-6.5 - 0 N=792 (28%)		0 - 8.5 N=637 (22%)		> 8.5 N=711 (25%)		P value	All N=2,855 (100%)	
Socio-Demographic											
Mean Age (as of month of first PAM survey)	40.0		38.7		39.6		40.4		0.05	39.6	
Gender, female	609	85%	671	85%	537	84%	608	86%	1.00	2425	85%
Race											
White non-Hispanic	203	28%	228	29%	185	29%	191	27%	0.96	807	28%
African-American	331	46%	350	44%	281	44%	325	46%		1287	45%
Hispanic	128	18%	140	18%	116	18%	132	19%		516	18%
Other	53	7%	74	9%	55	9%	63	9%		245	9%
Language, Spanish	32	4%	22	3%	20	3%	25	4%	0.34	99	3%
Home Medical Center											
East Bay	154	22%	168	21%	145	23%	143	20%	0.26	610	21%
Napa/Solano	223	31%	266	34%	223	35%	213	30%		925	32%
North Valley	197	28%	228	29%	166	26%	218	31%		809	28%
South Sacramento	141	20%	130	16%	103	16%	137	19%		511	18%
Poverty Rate (in home zip)	16.9		16.3		16.2		16.8		0.09	16.6	
College graduation rate(in home zip)	23.5		24.4		24.1		23.1		0.12	23.8	
Full or part-time work (at enrollment)	133	19%	167	21%	108	17%	159	22%	0.11	567	20%
Health Status and Conditions											
Health Status (at enrollment)											
Missing	3	0%	3	0%	3	0%	5	1%	0.82	14	0%
Poor	87	12%	85	11%	91	14%	99	14%	0.01	362	13%
Fair	216	30%	244	31%	223	35%	207	29%		890	31%
Good	262	37%	306	39%	204	32%	272	38%		1044	37%
Very good	93	13%	119	15%	87	14%	79	11%		378	13%
Excellent	54	8%	35	4%	29	5%	49	7%		167	6%

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 10 (continued): Patient Characteristics by Quartile of PAM Score Change from Last PAM Survey

Member Characteristics (month of the PAM survey unless specified)	Quartile of PAM score change from last survey										P value	All	
	< - 6.5 N=715 (25%)		-6.5 - 0 N=792 (28%)		0 - 8.5 N=637 (22%)		> 8.5 N=711 (25%)					N=2,855 (100%)	
Health Status and Conditions (continued)													
Smoking Status, current smoker	216	30%	215	27%	170	27%	189	27%			0.52	790	28%
BMI category, morbidly obese	172	24%	199	25%	163	26%	177	25%			0.95	711	25%
Substance abuse (at enrollment)	97	14%	109	14%	85	13%	99	14%			0.99	390	14%
Disabled (at enrollment)	309	43%	364	46%	273	43%	304	43%			0.75	1250	44%
Depression	299	42%	326	41%	275	43%	303	43%			0.94	1203	42%
Asthma	236	33%	272	34%	234	37%	229	32%			0.51	971	34%
Hypertention registry	260	36%	288	36%	258	41%	266	37%			0.56	1072	38%
Heart Failure registry	34	5%	28	4%	27	4%	38	5%			0.39	127	4%
Diabetes/Cardiovascular	191	27%	208	26%	189	30%	199	28%			0.63	787	28%
Clinical Risk and utilization													
Hospitalization risk	7.3%		7.3%		7.8%		7.6%				0.74	7.5%	
ED visits prior 180 days, annualized	2.8		2.1		2.1		2.1				0.33	2.3	
Hospital days prior 180 days, annualized	1.2		0.9		1.3		1.1				0.60	1.1	
Care Manager Contacts (monthly avg. last 120 days)													
Total interventions	1.66		1.65		2.00		1.85				0.01	1.78	
Coaching interventions	0.74		0.75		0.84		0.84				0.62	0.79	
Diagnosis	0.16		0.17		0.18		0.19				0.11	0.17	
Goals	0.10		0.09		0.09		0.10				0.44	0.09	
Diet	0.08		0.08		0.09		0.10				0.09	0.09	
Medication Reconciliation	0.08		0.08		0.09		0.09				0.66	0.08	
Benefits	0.08		0.07		0.07		0.08				0.63	0.07	
Non-Coaching Interventions	0.92		0.89		1.16		1.01				0.00	0.99	
Confirm Appointment	0.16		0.15		0.19		0.18				0.54	0.17	
Contact PCP	0.12		0.12		0.16		0.12				0.00	0.13	
Patient Meeting	0.10		0.09		0.12		0.10				0.04	0.10	
Refer to PCP	0.07		0.07		0.11		0.09				0.01	0.08	

Table 10 (continued): Patient Characteristics by Quartile of PAM Score Change from Last PAM Survey

Member Characteristics (month of the PAM survey unless specified)	Quartile of PAM score change from last survey											
	< - 6.5 N=715 (25%)		-6.5 - 0 N=792 (28%)		0 - 8.5 N=637 (22%)		> 8.5 N=711 (25%)		P value	All N=2,855 (100%)	
Care Manager Contacts (continued)											
Coaching share of total interventions	0.36		0.33		0.33		0.35		0.38	0.34	
Emotional support	0.34		0.35		0.41		0.37		0.02	0.37	
Failed outreach	0.16		0.14		0.16		0.16		0.35	0.16	
Study Characteristics											
Days from enrollments to first PAM	284		276		300		292		0.45	287	
Intervention days before first PAM	8.4		8.6		9.5		8.7		0.53	8.8	
Engagement/Activation Proxies											
Last PAM score Level											
1	20	3%	121	15%	156	24%	135	19%	0.00	432	15%
2	52	7%	149	19%	120	19%	172	24%		493	17%
3	204	29%	233	29%	178	28%	237	33%		852	30%
4	439	61%	289	36%	183	29%	167	23%		1,078	38%
Days from first PAM to this PAM survey	278		275		254		262		0.00	268	
Days from last PAM to this PAM survey	123		116		112		123		0.02	119	
Total PAM surveys during study	4.8		4.9		4.7		4.7		0.07	4.8	
Support System, significant (at enrollment)	175	24%	202	26%	154	24%	186	26%	0.87	717	25%
PCP changed, added, or none in last 12 mos.	112	16%	123	16%	112	18%	128	18%	0.55	475	17%
Sent messages within 12 months before first PAM	2.4		2.2		2.1		2.1		0.91	2.2	
MD understanding of needs (at enrollment)											
Unknown	29	4%	30	4%	29	5%	29	4%	0.92	117	4%
poor	20	3%	21	3%	21	3%	24	3%	0.07	86	3%
fair	71	10%	81	10%	75	12%	68	10%		295	10%
good	180	25%	200	25%	165	26%	186	26%		731	26%
very good	174	24%	247	31%	155	24%	173	24%		749	26%
excellent	241	34%	213	27%	192	30%	231	32%		877	31%

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables.

Table 11: Mean Interventions Rates by Category and Detail Type, by Last PAM Survey Level, and by Quartile of PAM Score Change (n=2,855)

Monthly Average (last 120 days) by Category and Detail Type and by Last PAM Level	Quartile of PAM score change from last survey					
	Q1 < -6.5	Q2 -6.5 – 0	Q3 0 – +8.5	Q4 >+8.5	P value for Differences across PAM change Qs	All
Last PAM Level 1	**N=20**	**N=121**	**N=156**	**N=135**	**0.00**	**N=432**
Total interventions	3.49	2.14	2.68	2.52	0.37	2.52
Coaching interventions	1.04	0.97	1.09	1.16	0.47	1.08
Diagnosis	0.29	0.25	0.28	0.30	0.32	0.28
Goals	0.04	0.08	0.13	0.13	0.25	0.11
Diet	0.08	0.11	0.10	0.15	0.19	0.12
Medication Reconciliation	0.09	0.12	0.14	0.14	0.41	0.13
Benefits	0.11	0.10	0.07	0.09	0.30	0.09
Non-coaching interventions	2.45	1.17	1.58	1.37	0.15	1.44
Confirm Appointment	0.29	0.21	0.31	0.26	0.06	0.27
Contact PCP	0.25	0.18	0.25	0.20	0.24	0.21
Patient Meeting	**0.18**	**0.07**	**0.16**	**0.13**	**0.01**	**0.13**
Refer to PCP	0.21	0.10	0.13	0.08	0.37	0.11
Coaching share of total	**0.25**	**0.40**	**0.34**	**0.44**	**0.00**	**0.38**
Emotional support	0.66	0.45	0.56	0.52	0.24	0.52
Failed outreach	0.24	0.19	0.18	0.20	0.44	0.19
Last PAM Level 2	**N=52**	**N=149**	**N=120**	**N=172**	**0.00**	**N=493**
Total interventions	**2.47**	**1.67**	**1.70**	**2.00**	**0.05**	**1.88**
Coaching interventions	**1.09**	**0.76**	**0.67**	**0.92**	**0.02**	**0.83**
Diagnosis	**0.23**	**0.15**	**0.14**	**0.22**	**0.02**	**0.18**
Goals	0.14	0.10	0.08	0.10	0.24	0.10
Diet	0.12	0.09	0.07	0.11	0.40	0.10
Medication Reconciliation	0.14	0.11	0.08	0.08	0.13	0.09
Benefits	**0.09**	**0.06**	**0.06**	**0.10**	**0.01**	**0.08**
Non-coaching interventions	1.38	0.91	1.03	1.08	0.24	1.05
Confirm Appointment	0.22	0.17	0.15	0.18	0.75	0.17
Contact PCP	0.25	0.12	0.15	0.14	0.56	0.15
Patient Meeting	0.12	0.11	0.10	0.11	0.87	0.11
Refer to PCP	0.08	0.07	0.10	0.10	0.69	0.09
Coaching share of total	**0.40**	**0.31**	**0.27**	**0.38**	**0.01**	**0.34**
Emotional support	0.40	0.34	0.37	0.39	0.57	0.37
Failed outreach	**0.27**	**0.15**	**0.15**	**0.18**	**0.04**	**0.17**

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables. Rows bolded if P <= 0.05.

Table 11 (continued): Mean Interventions Rates by Category and Detail Type, by Last PAM Survey Level, and by Quartile of PAM Score Change

Monthly Average (last 120 days) by Category and Detail Type and by Last PAM Level	Quartile of PAM score change from last survey					
	Q1 < -6.5	Q2 -6.5 – 0	Q3 0 – +8.5	Q4 >+8.5	P value for Differences across PAM change Qs	All
Last PAM Level 3	N=204	N=233	N=178	N=237	0.25	N=852
Total interventions	**1.88**	**1.45**	**1.80**	**1.51**	**0.02**	**1.65**
Coaching interventions	0.81	0.67	0.83	0.67	0.08	0.74
Diagnosis	0.19	0.16	0.16	0.14	0.10	0.16
Goals	0.10	0.08	0.08	0.09	0.77	0.09
Diet	0.08	0.06	0.10	0.07	0.11	0.07
Medication Reconciliation	0.09	0.07	0.07	0.09	0.63	0.08
Benefits	0.08	0.08	0.09	0.07	0.55	0.08
Non-coaching interventions	1.07	0.81	0.97	0.84	0.13	0.92
Confirm Appointment	0.19	0.15	0.13	0.16	0.16	0.16
Contact PCP	**0.15**	**0.09**	**0.11**	**0.08**	**0.00**	**0.11**
Patient Meeting	0.12	0.11	0.12	0.09	0.14	0.11
Refer to PCP	0.09	0.05	0.11	0.06	**0.04**	0.08
Coaching share of total	0.35	0.31	0.35	0.31	0.35	0.33
Emotional support	0.39	0.32	0.36	0.30	0.18	0.34
Failed outreach	**0.19**	**0.13**	**0.13**	**0.14**	**0.04**	**0.15**
Last PAM Level 4	**N=439**	**N=289**	**N=183**	**N=167**	**0.00**	**N=1078**
Total interventions	1.38	1.56	1.81	1.63	0.56	1.54
Coaching interventions	0.65	0.73	0.75	0.73	0.73	0.70
Diagnosis	0.13	0.15	0.16	0.15	0.86	0.15
Goals	0.10	0.10	0.09	0.10	0.77	0.10
Diet	0.07	0.09	0.10	0.08	0.23	0.08
Medication Reconciliation	0.06	0.06	0.07	0.05	0.45	0.06
Benefits	0.07	0.06	0.06	0.06	0.36	0.07
Non-coaching interventions	0.72	0.83	1.06	0.90	0.18	0.84
Confirm Appointment	0.13	0.13	0.17	0.13	0.76	0.14
Contact PCP	0.09	0.11	0.15	0.09	0.06	0.11
Patient Meeting	0.08	0.08	0.11	0.10	0.35	0.09
Refer to PCP	0.06	0.08	0.10	0.11	0.16	0.08
Coaching share of total	0.36	0.34	0.34	0.30	0.27	0.34
Emotional support	0.30	0.34	0.35	0.31	0.29	0.32
Failed outreach	0.12	0.13	0.18	0.15	0.26	0.14

Note: Kruskal-Wallis test for continuous variables, and chi-square test for categorical variables. Rows bolded if P <= 0.05.

Table 11 (continued): Mean Interventions Rates by Category and Detail Type, by Last PAM Survey Level, and by Quartile of PAM Score Change

Monthly Average (last 120 days) by Category and Detail Type and by Last PAM Level	Quartile of PAM score change from last survey					
	Q1 < -6.5	Q2 -6.5 – 0	Q3 0 – +8.5	Q4 >+8.5	P value for Differences across ***Last PAM Levels***	All
All Last PAM Levels	N=715	N=792	N=637	N=711		N=2855
Total interventions	1.66	1.65	2.00	1.85	**0.00**	**1.78**
Coaching Interventions	0.74	0.75	0.84	0.84	**0.00**	**0.79**
Diagnosis	0.16	0.17	0.18	0.19	**0.00**	**0.17**
Goals	0.10	0.09	0.09	0.10	0.69	0.09
Diet	0.08	0.08	0.09	0.10	**0.00**	**0.09**
Medication Reconciliation	0.08	0.08	0.09	0.09	**0.00**	**0.08**
Benefits	0.08	0.07	0.07	0.08	**0.01**	**0.07**
Non-coaching interventions	0.92	0.89	1.16	1.01	**0.00**	**0.99**
Confirm Appointment	0.16	0.15	0.19	0.18	**0.00**	**0.17**
Contact PCP	0.12	0.12	0.16	0.12	**0.00**	**0.13**
Patient Meeting	0.10	0.09	0.12	0.10	0.16	0.10
Refer to PCP	0.07	0.07	0.11	0.09	**0.00**	**0.08**
Coaching share of total	0.36	0.33	0.33	0.35	**0.01**	**0.34**
Emotional support	0.34	0.35	0.41	0.37	**0.00**	**0.37**
Failed outreach	0.16	0.14	0.16	0.16	**0.00**	**0.16**

Note: Kruskal-Wallis test for continuous variables. Rows bolded if P <= 0.05.

Table 12: Unadjusted and Adjusted Generalized Estimating Equations Results Modeling Change in PAM score, Controlling for Repeated Patient Measurement (Patients=915, N=2,855)

	Unadjusted		Adjusted	
	Estimate	**95% CI**	**Estimate**	**95% CI**
Intercept			-5.28 **	(-7.38 – -3.18)
Age, ref=19-49				
50 – 65	-0.54	(-1.25 – 0.18)	-1.07 *	(-2.08 – -0.07)
Gender, ref=male	0.51	(-0.36 – 1.39)	0.32	(-0.83 – 1.48)
Race, ref=White				
Hispanic	0.25	(-0.75 – 1.24)	0.79	(-0.50 – 2.08)
African-American	0.26	(-0.45 – 0.98)	0.54	(-0.49 – 1.56)
Other	0.28	(-0.71 – 1.26)	0.34	(-1.18 – 1.86)
Home service area, ref=East Bay, Napa, or North Valley				
South Sacramento	-0.23	(-1.07 – 0.61)	-1.23 *	(-2.32 – -0.14)
Working Status, ref=not working				
Part or full-time	0.77	(-0.04 – 1.59)	1.79 **	(0.71 – 2.88)
Smoking Status, ref=all other				
Current Smoker	-1.13 **	(-1.88 – -0.38)	-1.28 **	(-2.23 – -0.33)
ED visits last 6 mo, annualized, ref=<10				
>=10	-2.59 *	(-4.61 – -0.58)	-3.14 **	(-5.42 – -0.87)
Total inteventions in last 120 days				
Increase of 2.25 (IQ range)	0.36 *	(0.00 – 0.72)	0.19	(-0.22 – 0.60)
Coaching share of all inteventions in last 120 days				
Increase of 0.54 (IQ range)	-0.19	(-1.00 – 0.63)	See Interaction Table	
Last PAM Level, ref=Level 4				
1	11.83 **[33]	(10.38 – 13.27)	See Interaction Table	
2	11.21 **[33]	(9.68 – 12.73)		
3	8.09 **	(6.73 – 9.46)		
Support System, ref=some, none, unknown				
Significant	0.39	(-0.38 – 1.16)	1.95 **	(0.98 – 2.92)
MD understanding of needs, ref=unknown, poor, fair, good, very good				
Excellent	-0.15	(-0.85 – 0.55)	See Interaction Table	

Note: all comparisons use 95% two-sided Wald confidence intervals

*p<0.05 **p<0.01 [33] different from Level 3, p<0.01

Table 13: PAM Score Change at the 25th and 75th Percentiles of Coaching Proportion by Last PAM Level and MD Understanding of Patient Healthcare Needs (Patients=915, N=2,855)

		Coaching share of all inteventions in last 120 days				
		0 (25th Percentile)			0.54 (75th Percentile)	
Last PAM Level	MD understanding of health care needs	Estimate	95% CI		Estimate	95% CI
1	Unknown, Poor-Very Good	10.5 * [3]	(8.3 – 12.6)		12.1 ** [33]	(10.1 – 14.1)
	Excellent	10.9 * [44]	(8.0 – 13.9)	++	14.5 **## [44]	(12.1 – 16.9)
2	Unknown, Poor-Very Good	10.4 ** [3]	(8.2 – 12.6)		10.9 ** [33]	(8.8 – 12.9)
	Excellent	10.9 ** [44]	(8.0 – 13.8)	+	13.2 **## [44]	(10.8 – 15.6)
3	Unknown, Poor-Very Good	8.1 ** [44]	(6.0 – 10.1)		7.0 ** [44]	(5.0 – 8.9)
	Excellent	8.5 **	(5.7 – 11.4)		9.3 **##	(7.1 – 11.6)
4	Unknown, Poor-Very Good	0.0		+	-1.9 *	(-3.5 – -0.2)
	Excellent	0.5	(-1.0 – 2.0)		0.5 ##	(-1.3 – 2.3)

Note: All comparisons use 95% two-sided Wald confidence intervals. Analysis based on full GEE model with two-way interactions between "Coaching Proportion" and "Last PAM Level," and between "Coaching Proportion" and "MD Understanding."

** different from 0, p<0.01

* different from 0, p<0.05

[33] different from Level 3, p<0.01

[3] different from Level 3, p<0.05

[44] different from Level 4, p<0.01

different from Unknown, Poor-VG at p<0.01

++ different between 75th and 25th percentile of coach proportion, p<0.01

+ different between 75th and 25th percentile of coach proportion, p<0.05

Conclusion: Implications for policy and practice

A central goal of accountable providers (ACOs and HMOs), particularly with ACA implementation, is to identify high-cost patient sub-groups where the delivery system can take an action that will reduce costs or improve outcomes. The key for making this approach *cost-effective* is to find effective interventions *and* only use them in subgroups where they would have the greatest impact. We hypothesized that 1) PAM can be used to gauge the intensity or style of intervention a person needs; and 2) MI could be a promising intervention for high-cost or multiple chronic disease patients. MI alters stereotypes about what a person needs away from their diseases, barriers, and failures and toward what matters most to them as a person. Then, the care system's job is to provide the support to achieve their health-related goals.

The results of this project provide the following insights about the utility of this approach:

1. The PAM is probably most useful for targeting outcomes that are patient behavior sensitive. We found stronger and more consistent evidence that low patient activation is correlated with higher utilization risk for ED visits rather than for hospitalizations particularly within a relatively short time frame. Research has consistently found that ED visits are more preventable than hospitalizations.[2]
2. Motivational interviewing appears to improve self-management capabilities and should be considered for any care management program where patient behavior change is important. The overall intervention was associated with clinically meaningful PAM score improvements, particularly among patients who started with low self-management skills. This suggests that motivational interviewing could be an important strategy for health systems aiming to improve self-management behaviors.
3. People with the lowest initial activation seemed to improve their activation the most from the intervention. Rather than giving up on those who start with low self-management

capabilities, this group might benefit from the most care manager attention (which they did actually receive during this intervention).

4. PAM should be supplemented by other variables that are predictive of important outcomes. In this study, hospitalization risk, prior utilization, demographic factors, and engagement variables had a role in predicting future utilization (although with varying importance for hospitalization and ED visit risk). In deciding where to concentrate care management resources, a delivery system might focus on patients with higher future predicted utilization risk and lower PAM scores.
5. Patient activation levels and MI interventions seem to be more important among some groups of patients, but our results do not provide a clear enough picture to guide action. The PAM seems to be variably predictive of future utilization among subgroups of patients, and MI seems to have variable impact on PAM score change within subgroups. Low activation increased hospitalization risk among patients with significant support systems, but did not among those with no or some support. Low activation increased ED visit risk among patients without a stable PCP. A higher share of coaching interventions was associated with larger PAM score improvements among low activation patients who reported "Excellent" physician understanding of their needs. Although some of these subgroup findings are intuitive, they suggest that patient activation and motivational interviewing have variable effects and that this variation might be explained by variables that we could not include in our study.
6. Groupings of PAM Levels might be the best guide for targeting interventions. Our findings in the three manuscripts suggest thresholds for PAM effects. For example, in predicting hospitalizations, PAM Levels 1, 2, and 3 could not be statistically distinguished; hospitalization risk for patients with "Significant" support systems only decreased at Level 4. ED visit risk reduction could not be statistically distinguished among PAM Levels 2, 3, and 4; ED visit risk for subgroups was only higher at Level 1.

In Manuscript 3, PAM score changes could not be distinguished between Levels 1 and 2. These observations could be artifacts of our sample sizes and selection of variables, but they warrant additional exploration in practice and research.

The following issues were not resolved by this study, and require further research:

1. How should MI strategies be tailored for maximum cost-effectiveness? This study found suggestive evidence that a higher share of coaching interventions led to larger PAM score improvements for some low activation patients, and that overall lower activation patients seem to improve PAM scores the most. We also found that low activation patients with an unstable PCP connection had a higher risk of future ED visits. However, our study design does not allow us to make strong conclusions on causation; these findings are primarily hypothesis generating. We need more rigorous evaluation of which subgroups of patients benefit from MI, and which do well with no or minimal intervention. It is also important to study whether MI could be effectively tailored to subgroups without the expense of measuring PAM.
2. What variables might be substitutes or complements to PAM for subgrouping patients for skill-based or MI interventions? Although this study attempted to distinguish the effects of PAM from potential substitutes, we were not able to directly measure socioeconomic status (income and education) or, more importantly, health literacy. Research has found a strong interaction between a patient's health literacy and participatory decision-making with their physicians.[69] A recent careful study found that although health literacy and PAM were weakly correlated, they made independent contributions to important health outcomes and were both good targets for intervention.[70] These authors suggest health literacy measurement could guide skill-based intervention, and patient activation measurement could guide motivational interventions. Non-survey alternatives to PAM might also include medication adherence, missed appointments, or other "effective"

engagement measures. In exploring engagement substitutes for PAM, research will need to focus on disentangling what appears to be higher engagement from simply a person needing more healthcare services.

3. How should a provider system ensure that it has effectively implemented MI? MI can be difficult to implement consistently, particularly because it challenges many of the shared beliefs of healthcare professionals. Anecdotally, a number of care managers in the intervention we studied were very uncomfortable with the MI approach, feeling that it did not address patients' needs or was contrary to their clinical duty. How important is intervention fidelity, initial care manager training, and ongoing support to ensure that MI is effective?

Appendices

Additional Methods Information

Timing of "First Intervention" and the PAM survey

Because four lists were sent to care managers before the program started using the PAM survey, almost half of the 1,041 study participants received their first care management interventions before 12/1/2009. Appendix Figure 4 below shows the entire duration of the study from January 2008 through the end in December 2012. The five graphs show the frequency of "first interventions" and first PAM surveys by month. For the purposes of the study, "first intervention" is the earlier of the members' coded enrollment date in the study and the first intervention coded by care managers in MediTrak. Care managers could have been intervening with a member for a year or more before they coded "enrollment" in MediTrak.

Data sources

The data for this study was built from six sources:

1. Underlying study data. This information was collected as part of the administration of the study and includes the list of members selected, dates and types of interventions by care managers, and results of the baseline survey completed at time of enrollment.
2. Utilization Datamart. KPNC creates inpatient and outpatient utilization analytical files for management reporting from the Kaiser Permanente Health Connect (KPHC) EMR system and from the small number of outside claims.
3. Membership Datamart. KPNC creates membership analytical files comprising all membership periods from all payers.
4. Clarity. For variables measuring patient use of our electronic medical record system, and secure messages to and from members, we extracted information directly from the reporting extract from KPHC.

5. Population Management Tool (PMT). TPMG maintains population registries to conduct population in care management programs. The extract from PMT includes registry, care management, and PCP information.
6. Division of Research. The KPNC Division of Research conducts studies focused on racial and ethnic disparities. They are experts at combining information on race and ethnicity from membership files and Clarity. Using their standard methods, they created race, ethnicity, and spoken language variables for our study data set.
7. RHO2 Hospitalization risk. Hospital risk score is calculated for almost every month for all KPNC members and available on the KPNC mainframe.

Appendix Tables and Figures

Appendix Table 14: 13-item PAM instrument and Mean Item Responses by First PAM Survey Score Level[36]

PAM Item Number and Text		Level 1 n=179 17%	Level 2 n=212 20%	Level 3 n=303 29%	Level 4 n=179 33%	All n=1,041 100%
1	When all is said and done, I am the person who is responsible for managing my health condition	3.11	3.33	3.57	3.88	3.55
2	Taking an active role in my own health care is the most important factor in determining my health and ability to function	3.06	3.25	3.48	3.84	3.48
3	I am confident that I can take actions that will help prevent or minimize some symptoms or problems associated with my health condition	2.62	2.88	3.14	3.70	3.19
4	I know what each of my prescribed medications do	2.70	3.06	3.26	3.72	3.27
5	I am confident that I can tell when I need to go get medical care and when I can handle a health problem myself	2.65	3.03	3.29	3.70	3.27
6	I am confident I can tell my health care provider concerns I have even when he or she does not ask	2.72	3.03	3.25	3.73	3.28
7	I am confident that I can follow through on medical treatments I need to do at home	2.76	2.99	3.18	3.78	3.27
8	I understand the nature and causes of my health condition(s)	2.32	2.74	2.91	3.59	3.00
9	I know the different medical treatment options available for my health condition	2.30	2.64	2.80	3.44	2.89
10	I have been able to maintain the lifestyle changes for my health that I have made	2.02	2.38	2.76	3.19	2.70
11	I know how to prevent further problems with my health condition	2.34	2.81	2.92	3.51	3.00
12	I am confident I can figure out solutions when new situations or problems arise with my health condition	2.19	2.59	2.85	3.39	2.86
13	I am confident that I can maintain lifestyle changes like diet and exercise even during times of stress	1.98	2.34	2.72	3.26	2.70

Note:

- Responses coded as 1=Disagree Strongly, 2=Disagree, 3=Agree, 4=Agree Strongly
- Missing responses to items not included in means

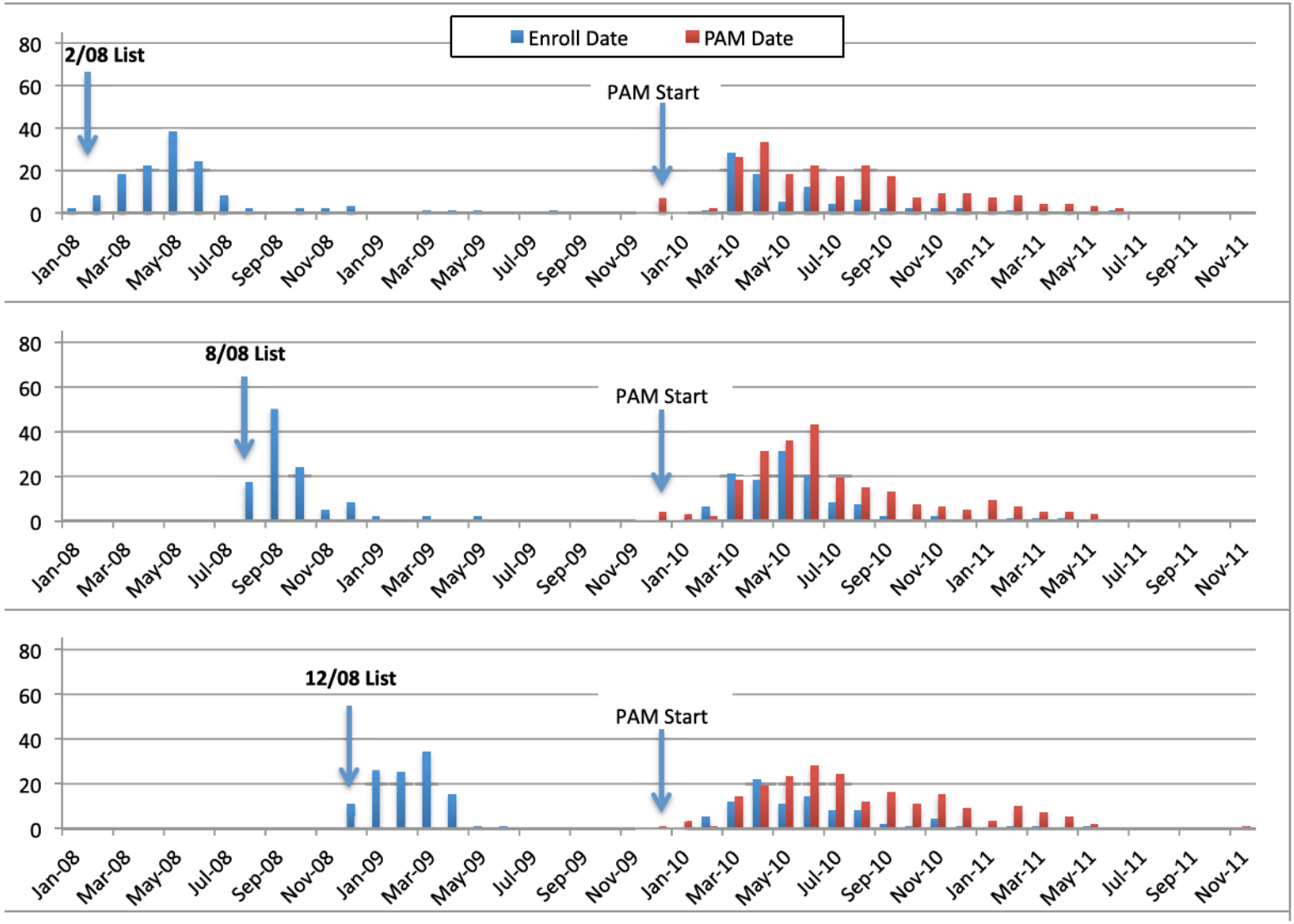
Appendix Table 15: Distribution of PAM score, PAM Score Change from Last Survey, and Interval Between PAM Surveys by number of PAM Surveys Completed

			PAM score (0-100)			PAM score change from last			Days from last PAM survey		
PAM Survey	N of Study Participants Completing	% of All Participants	Mean	Median	Interquartile range	Mean	Median	Interquartile range	Mean	Median	Interquartile range
1st	1041	100%	61.0	60.0	49.9 - 70.8			-			
2nd	915	88%	63.2	60.0	52.9 - 73.1	2.5	2.2	-5.3 - 9.6	136	98	90 - 154
3rd	760	73%	63.8	61.6	52.9 - 75.3	0.5	0.0	-6.8 - 7.2	120	97	89 - 134
4th	659	63%	65.5	63.2	52.9 - 77.5	2.0	0.0	-5.3 - 9.0	105	92	81 - 116
5th	298	29%	65.7	63.2	52.9 - 77.5	-1.0	0.0	-8.2 - 6.0	107	97	87 - 120
6th	158	15%	67.3	66.0	52.9 - 80.0	1.6	0.0	-5.3 - 9.0	98	93	81 - 106
7th	57	5%	67.6	66.0	52.9 - 77.5	-3.1	0.0	-9.0 - 4.5	98	93	86 - 109
8th	8	1%	70.6	69.6	56.4 - 81.4	2.7	0.0	-2.2 - 7.4	89	92	84 - 99
2nd-8th	915	88%	64.5	63.2	52.9 - 75.3	1.3	0.0	-6.5 - 8.5	119	95	88 - 125

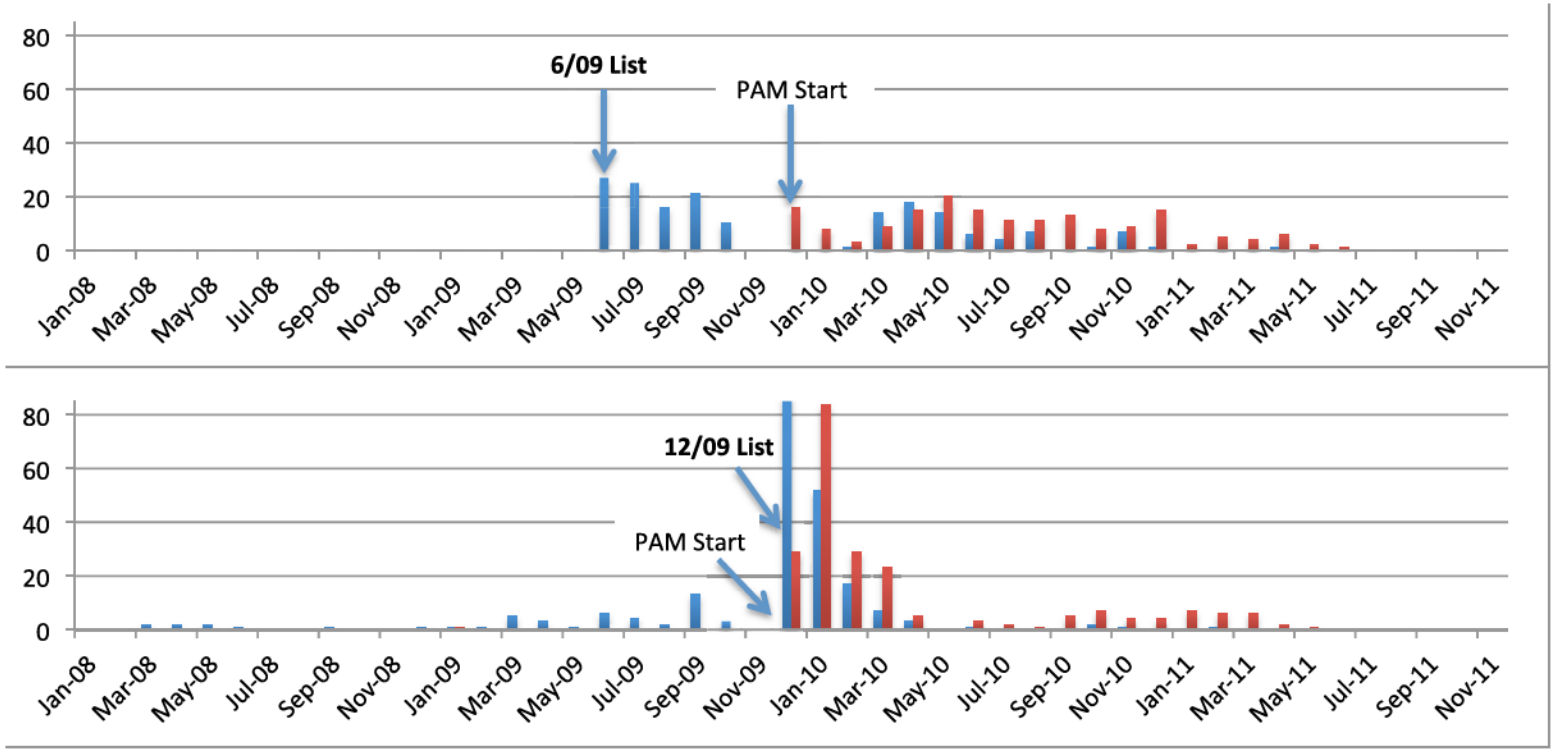
Appendix Table 16: Baseline Survey Instrument

1. How well does Kaiser Permanente take care of your healthcare needs?
2. How well does your personal physician understand your healthcare needs?
3. Do you know whom to call to obtain Kaiser Permanente services that you need?
4. How accessible/available are Kaiser Permanente's specialists when you need to meet with one (e.g., ophthalmologist, allergist, and neurologist, etc.)?
5. Rate Kaiser Permanente's ability to provide for your healthcare needs compared to other providers.
6. In general, how would you rate your health?

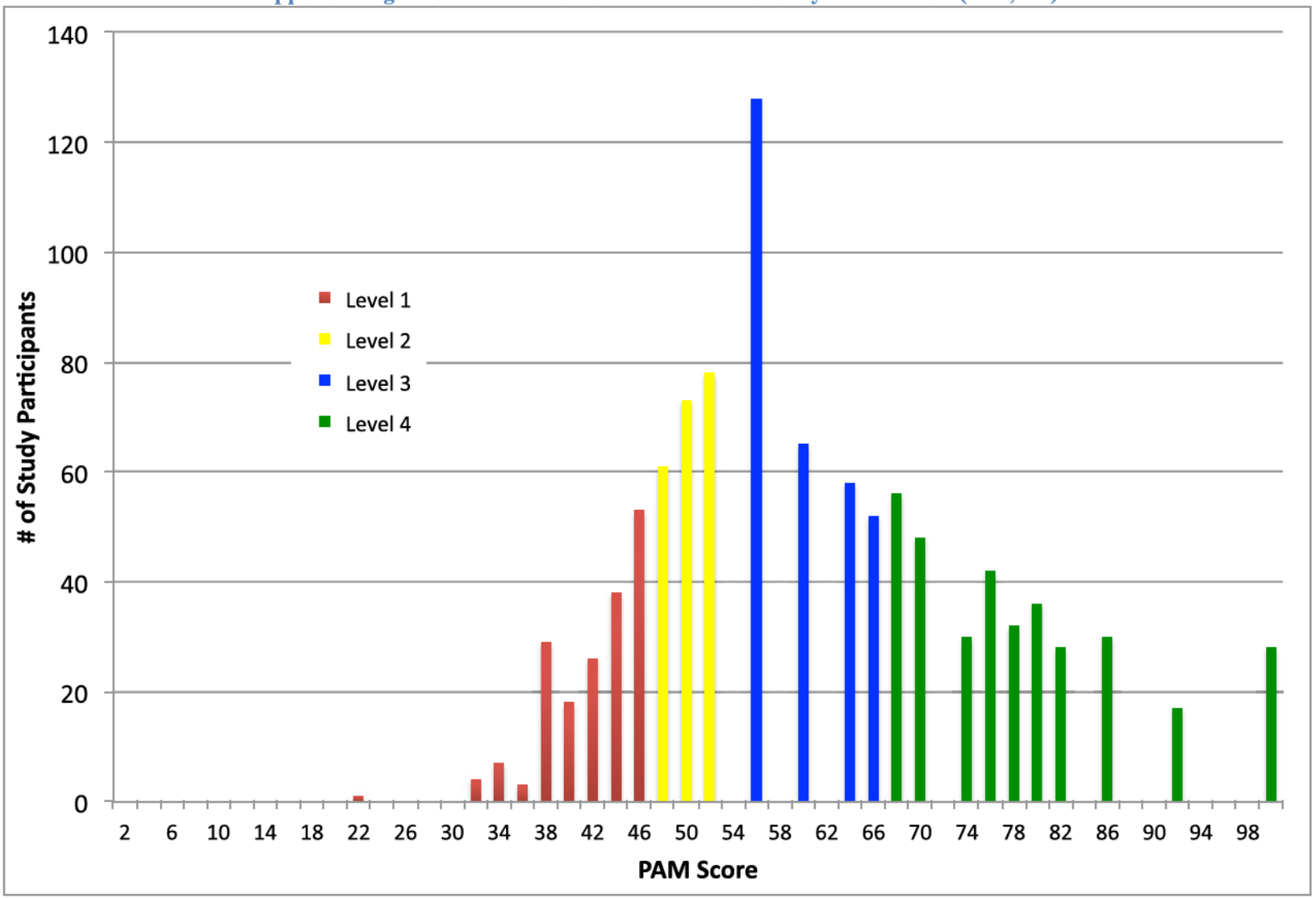
Appendix Figure 4: Number of Enrollments (modified) and PAM Surveys by Month and Study List



Appendix Figure 4 (continued): Number of Enrollments (modified) and PAM Surveys by Month and Study List



Appendix Figure 5: Distribution of First PAM scores by PAM Levels (N=1,041)



Appendix Table 17: Distribution of Number of Hospitalizations During Follow-up Period

Total # of Hospitalizations During Study	# of Participants with Hospitalization total	% of Participants	Cumulative %
0	768	74%	74%
1	163	16%	89%
2	59	6%	95%
3	21	2%	97%
4	11	1%	98%
5	4	0%	99%
6	4	0%	99%
7	5	0%	99%
8	2	0%	100%
9	0	0%	100%
10	1	0%	100%
11	1	0%	100%
12	1	0%	100%
13	0	0%	100%
14	0	0%	100%
15	0	0%	100%
16	1	0%	100%
	1,041		

Appendix Table 18: Distribution of Number of Emergency Department visits During Follow-up Period (excluding three extreme observations with 75, 124, and 234 ED visits during follow-up)

Total # of ED visits	# of Participants	% of Participants	Cumulative %
0	311	30%	30%
1	210	20%	50%
2	158	15%	65%
3	107	10%	76%
4	62	6%	82%
5	48	5%	86%
6	33	3%	89%
7	24	2%	92%
8	15	1%	93%
9	12	1%	94%
10	10	1%	95%
11	5	0%	96%
12	11	1%	97%
13	6	1%	97%
14	1	0%	98%
15	5	0%	98%
16	3	0%	98%
17	6	1%	99%
18	2	0%	99%
21	3	0%	99%
22	2	0%	100%
26	1	0%	100%
28	1	0%	100%
34	1	0%	100%
44	1	0%	100%
	1,038		

Appendix Table 19: Intervention description, categorization, and frequency for members with multiple PAM surveys

Code	Description	Type	Count	%
1	Advance Directive Placed in onsite medical center location	Non-Coaching	2	0.0%
2	Arranged/Utilized authorized Title 22 non-urgent or emergent transportation	Non-Coaching	10	0.0%
3	Arranged/Attended Clinic visit (routine or urgent)	Non-Coaching	436	1.2%
4	Arranged/Utilized DME	Non-Coaching	72	0.2%
5	Arranged/Utilized Language Interpreter Service	Non-Coaching	71	0.2%
6	Arranged/Utilized non-urgent or emergent transportation services	Non-Coaching	147	0.4%
7	**Arranged/Kept meeting (patient, family/significant other, or provider)**	**Non-Coaching**	**1079**	**3.1%**
8	Assistance with forms/apps related to community, financial, or legal resources	Non-Coaching	338	1.0%
9	Attend Member's clinic visit	Non-Coaching	96	0.3%
10	Contact Board & Care / Assisted Living staff	Non-Coaching	8	0.0%
11	Contact Chronic Conditions Program staff	Non-Coaching	97	0.3%
12	Contact Discharge Planner	Non-Coaching	18	0.1%
13	Contact DME staff	Non-Coaching	49	0.1%
15	Contact Home Health staff	Non-Coaching	6	0.0%
16	Contact Hospital Based staff (MD and Non MD)	Non-Coaching	48	0.1%
17	Contact Member Services	Non-Coaching	43	0.1%
18	Contact Palliative Care Services staff	Non-Coaching	2	0.0%
19	Contact Police, Child Protective Services, Adult Protective Services	Non-Coaching	9	0.0%
20	Contact SNF MD or RN	Non-Coaching	9	0.0%
21	Contact Specialist (MD and Non MD)	Non-Coaching	589	1.7%
22	**Contact PCP**	**Non-Coaching**	**1712**	**4.8%**
23	Coordinated/Utilized urgent or emergent services (e.g. call 911)	Non-Coaching	45	0.1%
24	Establish appropriate "Alerts" in CIPS/Health Connect	Non-Coaching	333	0.9%
25	**Medication reconciliation**	**Coaching**	**1092**	**3.1%**
26	**Provide emotional support**	**Emotional**	**5426**	**15.4%**
27	Advance Directive discussed	Coaching	97	0.3%
28	Ambulance benefit and appropriate use of ambulance service	Coaching	14	0.0%

Appendix Table 19 (Continued): Intervention description, categorization, and frequency for members with multiple PAM surveys

Code	Description	Type	Count	%
29	**Benefit Interpretation (DME, co-pay, etc.)**	**Coaching**	**1047**	**3.0%**
30	**Educated on/Accurately Utilized Diet/Nutrition/Exercise**	**Coaching**	**1456**	**4.1%**
31	Educated on/Accurately Utilized: Routine, Urgent, and ED Services	Coaching	654	1.9%
32	Educated on/Accurately Utilized Health Education materials	Coaching	638	1.8%
33	Educated on/Accurately Utilized Home safety (fall prevention, etc.)	Coaching	351	1.0%
35	Educated on/Accurately Accessed Advice Nurse/Call Center	Coaching	643	1.8%
36	Educated on/Accurately Utilized KP.org internet access and usage	Coaching	368	1.0%
37	Educated on/Accurately Utilized medication mngmt. (mail order)	Coaching	494	1.4%
38	Educated on/Accurately Verbalized information on New diagnosis (what it is, lifestyle impacts, rx management, …)	Coaching	287	0.8%
39	Referred to/Attended Alcoholics Anonymous	Non-Coaching	26	0.1%
40	Referred to/Attended Narcotics Anonymous	Non-Coaching	11	0.0%
41	Referred to/Attended Chemical Dependency Recovery Program (Kaiser)	Non-Coaching	27	0.1%
42	Referred to/Attended chemical dependency in the community	Non-Coaching	17	0.0%
43	Referred to/Utilized Mental Health Crisis Line	Non-Coaching	131	0.4%
44	Referred to/Attended Mental Health department	Non-Coaching	130	0.4%
45	**Referred to/Utilized PCP**	**Non-Coaching**	**1162**	**3.3%**
46	Referred to/Attended Pharmacy Medication Education	Non-Coaching	29	0.1%
47	Referred to/Utilized Physician Selection services	Non-Coaching	602	1.7%
48	Referred to/Attended Chemical Dependency program (Self Referral)	Non-Coaching	3	0.0%
49	Referred to/Attended Substance Abuse program (Self Referral)	Non-Coaching	5	0.0%
50	Referred to/Utilized Mental Health or Behavior Medicine Services	Non-Coaching	425	1.2%
51	Referral to Quality Assurance (QA) program	Non-Coaching	2	0.0%
52	Referred to/Utilized Clin. Health Ed. services or Health Ed. classes	Non-Coaching	470	1.3%
53	Referred to/ Utilized Dietician, Nutritionist, or Weight Mngmt.	Non-Coaching	104	0.3%
54	Referred to/Attended Disease Management program	Non-Coaching	39	0.1%
55	Referred to/Attended Health Education program	Non-Coaching	99	0.3%

Appendix Table 19 (Continued): Intervention description, categorization, and frequency for members with multiple PAM surveys

Code	Description	Type	Count	%
56	Referred to/Received Home Health Services	Non-Coaching	2	0.0%
57	Referred to/Received other Case Mngmt/Disease Mngmt	Non-Coaching	136	0.4%
59	Referred to/Utilized Member Services (benefit questions, complaint or grievance, moved out of Service Area)	Non-Coaching	74	0.2%
60	Referred to/Utilized Community Resources (including senior services organization)	Non-Coaching	288	0.8%
61	Contact Community Resources	Non-Coaching	213	0.6%
62	Collaboration with relatives / caregivers to assure care	Non-Coaching	368	1.0%
63	**Educated on/Accurately Verbalized information on Existing diagnosis (what it is, lifestyle impacts, rx management, …)**	**Coaching**	**2592**	**7.3%**
64	Referred to/Utilized Dental Care	Non-Coaching	105	0.3%
65	Referred to/Utilized Smoking Cessation Services	Non-Coaching	109	0.3%
66	**Attempt to reach Member**	**Failed**	**5361**	**15.2%**
67	**Confirm Member Appointment**	**Non-Coaching**	**1913**	**5.4%**
68	Contact Health Education	Non-Coaching	30	0.1%
69	Referred to/Utilized Community Resources for Food Bank/Closets	Non-Coaching	45	0.1%
70	Referred to/Utilized Community Resources for Transportation	Non-Coaching	102	0.3%
71	Referred to/Utilized Community Resources for In-home Supportive Services/Chore Provider Services	Non-Coaching	93	0.3%
72	Referred to/Utilized Community Resources for Housing/Homeless Shelter Referrals	Non-Coaching	49	0.1%
73	Referred to/Utilized Community Resources for Financial Resources/Benefits (GA, Food Stamps/SDI/Emergency	Non-Coaching	33	0.1%
74	Referred to/Utilized Community Resources for Legal (Recommending patient to take out restraining order)	Non-Coaching	17	0.0%
75	Referred to/Utilized Community Resources for Low Income Utilities	Non-Coaching	19	0.1%
76	Referred to/Utilized Community Resources for Medi-Cal	Non-Coaching	174	0.5%

Appendix Table 19 (Continued): Intervention description, categorization, and frequency for members with multiple PAM surveys

Code	Description	Type	Count	%
77	Referred to/Utilized Community Resources for Social Security	Non-Coaching	12	0.0%
78	Referred to/Utilized Community Resources for SSI Supp. Security Inc.	Non-Coaching	9	0.0%
79	Referred to/Utilized Community Resources for Support Group	Non-Coaching	51	0.1%
80	Referred to/Utilized Community Resources for Day Activity Programs	Non-Coaching	12	0.0%
81	Referred to/Utilized Community Resources for Crisis Nursery	Non-Coaching	13	0.0%
82	Referred to/Utilized Business Office Services (Billing Collection, etc.)	Non-Coaching	7	0.0%
83	Contact Mental Health staff and/or Chemical Dependency Staff	Non-Coaching	61	0.2%
84	Contact Pharmacy staff	Non-Coaching	15	0.0%
85	Contact OB/Gyn	Non-Coaching	86	0.2%
87	Educated on/Completed Labs or Diagnostic Tests	Coaching	657	1.9%
88	**Educated on/Accurately verbalized treatment goals**	**Coaching**	**1515**	**4.3%**
90	Referred to/Utilized Ob/Gyn	Non-Coaching	106	0.3%

Note: The count is the total number of interventions or failed interventions between the first PAM survey and the last PAM survey for that member. Intervention is bolded if its total frequency is greater than or equal to 2% of the total.

Appendix Table 20: Distribution of interventions and failed interventions by intervention category and detailed type for patients with multiple PAM surveys

Intervention type	Total	Frequency %
Coaching	11,905	34%
Educated on existing diagnosis	2,592	7%
Educated on treatment goals	1,515	4%
Educated on Diet, Nutrition, or Exercise	1,456	4%
Medication reconciliation	1,092	3%
Benefit Interpretation	1,047	3%
All other coaching	4,203	12%
Non-Coaching	12,643	36%
Confirm Member Appointment	1,913	5%
Contact PCP	1,712	5%
Referred to/Utilized PCP	1,162	3%
Arranged/kept patient or family meeting	1,079	3%
All other non-coaching	6,777	19%
Provide emotional support	5,426	15%
Failed outreach for intervention	5,361	15%
Total	**35,335**	100%

Note:

- The count is the total number of interventions or failed interventions between the first PAM survey and the last PAM survey for that member
- Detailed types included in table if their total frequency is greater than or equal to 2% of the total

Appendix Table 21: Mean Change in PAM Item Response (last survey minus first survey) by first PAM Level and Score Change Quartile

		First PAM Survey Level	Level 1					Level 2					Level 3					Level 4					All
		Quartile of Last-First Score Δ	ΔQ1	ΔQ2	ΔQ3	ΔQ4	All	ΔQ1	ΔQ2	ΔQ3	ΔQ4	All	ΔQ1	ΔQ2	ΔQ3	ΔQ4	All	ΔQ1	ΔQ2	ΔQ3	ΔQ4	All	
		Members in Category	7	43	52	61	163	23	46	46	67	182	70	65	72	60	267	122	87	48	46	303	915
PAM Item (abbreviated)	1	I am responsible	-0.3	0.1	0.1	**0.6**	**0.3**	-0.2	0.0	0.1	**0.5**	**0.2**	**-0.4**	0.0	0.1	**0.4**	0.0	**-0.3**	0.0	**0.2**	0.1	**-0.1**	**0.1**
	2	Active role is important	0.0	0.0	**0.2**	**0.6**	**0.3**	**-0.3**	-0.1	-0.1	**0.5**	**0.1**	**-0.5**	0.0	**0.2**	**0.6**	0.1	**-0.3**	0.0	**0.1**	**0.3**	-0.1	**0.1**
	3	Confident can minimize problems	-0.2	**-0.3**	**0.3**	**0.6**	**0.3**	**-0.3**	-0.1	0.2	**0.6**	**0.2**	**-0.5**	0.0	0.1	**0.6**	0.0	**-0.6**	**-0.2**	**0.2**	**0.3**	**-0.2**	0.0
	4	Know what medications	-0.1	0.0	**0.3**	**0.6**	**0.3**	**-0.4**	-0.2	**0.2**	**0.5**	**0.1**	**-0.5**	-0.1	**0.3**	**0.6**	0.1	**-0.4**	0.1	**0.2**	**0.3**	**-0.1**	**0.1**
	5	Confident know when need care	**-0.9**	0.0	**0.3**	**0.7**	**0.3**	**-0.3**	-0.2	0.0	**0.5**	0.1	**-0.5**	-0.1	**0.3**	**0.7**	0.1	**-0.5**	0.0	0.1	**0.2**	**-0.1**	**0.1**
	6	Confident can tell provider concerns	**-1.3**	0.0	0.2	**0.7**	**0.3**	**-0.4**	-0.1	0.1	**0.5**	**0.1**	-0.1	0.0	**0.2**	**0.7**	**0.2**	**-0.4**	0.0	0.1	**0.4**	-0.1	**0.1**
	7	Confident can follow through on treatments	-0.6	**-0.3**	0.2	**0.6**	**0.2**	**-0.5**	0.0	0.0	**0.6**	**0.2**	**-0.2**	0.0	**0.2**	**0.8**	0.2	**-0.6**	0.0	0.1	**0.2**	**-0.2**	**0.1**
	8	Understand the nature of condition(s)	-0.3	0.1	0.0	**0.9**	**0.3**	**-0.4**	-0.1	**0.2**	**0.6**	**0.2**	**-0.2**	0.0	0.2	**0.6**	0.1	**-0.5**	-0.1	0.1	**0.3**	**-0.2**	**0.1**
	9	Know treatment options	0.0	0.0	**0.3**	**0.6**	**0.3**	-0.2	**0.2**	0.0	**0.7**	**0.3**	-0.1	0.0	**0.2**	**0.8**	0.2	**-0.4**	0.0	0.1	**0.5**	-0.1	**0.2**
	10	Able to maintain lifestyle changes	0.1	0.0	**0.3**	**1.1**	**0.5**	-0.2	0.1	**0.5**	**0.9**	**0.5**	**-0.2**	0.0	**0.3**	**0.7**	**0.2**	**-0.4**	0.0	**0.4**	**0.8**	0.1	**0.3**
	11	Know how to prevent further problems	0.0	0.0	0.2	**0.7**	**0.3**	**-0.5**	-0.2	0.2	**0.5**	**0.1**	**-0.3**	0.0	**0.1**	**0.7**	**0.1**	**-0.6**	-0.1	0.0	**0.5**	**-0.2**	**0.1**
	12	Confident can solve new problems	-0.3	-0.1	**0.3**	**0.9**	**0.4**	**-0.3**	0.1	0.1	**0.7**	**0.3**	-0.1	0.0	**0.3**	**0.7**	**0.2**	**-0.4**	-0.1	**0.4**	**0.8**	0.0	**0.2**
	13	Confident can maintain lifestyle changes during stress	**-0.6**	-0.1	**0.2**	**0.9**	**0.3**	-0.2	-0.2	**0.5**	**0.8**	**0.4**	**-0.2**	-0.1	**0.3**	**0.9**	**0.2**	**-0.4**	**-0.3**	**0.3**	**0.8**	-0.1	**0.2**

Notes: Item response differences bolded if paired t-test p-value <= 0.05. Responses coded as 1=Disagree Strongly, 2=Disagree, 3=Agree, 4=Agree Strongly. Missing responses to items not included in means. PAM score change quartiles based on a median (interquartile range) of the last minus first PAM score change of 2.8 (-4.8-12.6).

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Curriculum Vitae

Birth: November 27, 1963

Education/Training

Institution and Location	Degree	Years	Field of Study
Princeton University, Princeton, New Jersey	BSE	1982-1986	Civil Engineering (Operations Research) & Public Policy
Harvard University, John F. Kennedy School of Government, Boston, MA.	MPP	1988-1990	Public Policy
Johns Hopkins University School of Public Health, Baltimore, MD	DrPH expected 2014	2008-present	Health Policy & Management

Relevant Research and Professional Experience

Institution and Location	Title / Role	Years
TPMG, Dept. of Quality and Operations Support, Oakland, CA	Director	2011- present
Johns Hopkins University, Baltimore, MD	Administrator, Div. of Cardiology, Dept. of Medicine	2009-2011
The Johns Hopkins Hospital, Baltimore, MD	Director, Quality Improvement	2007-2009
University of Mississippi Medical Center (UMMC), Jackson, MS	Sr. Consultant, Clinical Systems Improvement; Asst. Prof, School of Medicine; Lecturer, School of Nursing	2004-2007
Robert Wood Johnson Foundation, Princeton, NJ	Senior Program Officer	1998-2004
MBR Consulting, Denver, CO	Independent Health Care Policy Analysis Consultant	1998
State of Colorado, Dept. of Health Care Policy and Financing, Denver, CO	Director, Office of Public and Private Initiatives	1994-1997
State of Colorado, Office of the Gov., Denver, CO	Health Economist	1992 – 1994
Mel Levine for U.S. Senate, Los Angeles, CA	Director of Research	1992
Kaiser Permanente of Northern Calif., Dept. of Medical Economics, Oakland, CA	Analyst, Rates Benefits, and Policy Development	1991
RAND Corporation, Santa Monica, CA	Assistant Mathematician	1985-1990

Professional Organizations

Senior Member, American Society for Quality

Academy for Healthcare Improvement

Committee Memberships (selected: recent and nationally prominent)

Member, Editorial Advisory Board, *Quality Matters: Monthly Updates from the Commonwealth Fund,* 2005-current.

Examiner, Malcolm Baldrige National Quality Award (MBNQA), 2008

External Reviewer, The Robert Wood Johnson Foundation's *Interdisciplinary Nursing Quality Research Initiative,* 2008 and 2009.

Reviewer, Institute of Medicine, *Rewarding Provider Performance: Aligning Incentives in Medicare*, Pathways to Quality Health Care Series, Committee on Redesigning Health Insurance Performance Measures, Payment, and Performance Improvement Programs, Board on Health Care Services, 2006.

Reviewer, Institute of Medicine, *Medicare's Quality Improvement Program: Maximizing Potential*, Pathways to Quality Health Care Series, Committee on Redesigning Health Insurance Performance Measures, Payment, and Performance Improvement Programs, Board on Health Care Services, 2006.

Selected Publications

"Measuring and Improving Quality of Health Care: The Interaction of the Family System and the Health Care System," Panel on Performance Measurement and Quality Improvement, Association for Public Policy and Management Fall Research Conference, Washington, DC, November 2003.

Co-authored "Case study: Colorado Medicaid HMO risk adjustment," in *Inquiry*. 1998 Summer; 35(2): 154-70.

Presentations (selected: only very large audiences)

"Perfection, Pursuit, and Return," Keynote address, 10th Annual Kansas Health Quality Forum, Kansas Foundation for Medical Care, Wichita, KS, April 2005, (750 in audience).

"Pursuing Perfection: Raising the Bar for Healthcare Performance," Keynote address, National Association for Health Care Quality 29th Annual Conference, Orlando, FL, September 2004, (1000 in audience).

"How a private funder thinks about improving quality of care in a system where nobody is in charge," Global Health Symposium: Taming Health Care Systems, sponsored by Adelphi University, New York, NY, December 2003 (200 in audience).